3 CURRENT CONDITIONS

3.1 AQUATIC SPECIES AND HABITAT

This section of the watershed analysis describes the distribution, presence and absence of aquatic species, and the current habitat conditions with a focus on near-term large wood debris (LWD) recruitment, vegetative stream shading, water quality and quantity, and physical habitat characteristics.

3.1.1 Fisheries

3.1.1.1 Range of Fish Occurrence

Species occurrence (i.e., presence/absence) data were obtained from stream inventories, ODFW records and from written or verbal documentation of other agencies, tribes, or archived literature (USFS GIS metadata 2000). Fish species identified as present in the watershed are listed in Table 3.1. The species listed as ONMY take into account steelhead, rainbow, and redband trout. Fish surveyors use this code when unable to differentiate among these species, a common dilemma when observing juvenile fish. Dace and red shiners are likely to be present in the watershed, but there are no survey data to determine distribution and abundance of these species (Edwards, pers. comm. 2002).

Table 3.1. Six fish species known to occur in Canyon Creek watershed.

Fish code	Scientific name	Common name
COXX	*Cottus sp.*	Sculpins
ONCL	*Oncorhynchus clarkii*	Cutthroat trout
ONMY	*Oncorhynchus mykiss*	Steelhead, rainbow, redband trout
SAFO	*Salvelinus fontinalis*	Brook trout
ONTS1	*Oncorynchus tshawytscha*	Spring Chinook salmon
ONMY1	*Oncorhynchus mykiss*	Steelhead trout
ONMY3	*Oncorhynchus mykiss*	Redband trout

Fish are present in all subwatersheds of Canyon Creek except Byram Gulch (Table 3.2, Map 3.1) (USFS Stream Coverage 2002). The distribution of certain species within the reaches of each subwatershed is described in this section.

3.1.1.1.1 Berry Creek Subwatershed

Juvenile Chinook salmon occur in the Berry Creek subwatershed of Canyon Creek. Cutthroat trout are limited to approximately three miles of Berry Creek where the upper extent of their range most likely is limited by gradient (Reach 3 exceeds 20%). Steelhead and redband trout occur in both Canyon Creek and Berry Creek.

Table 3.2. Fish species presence and linear length along streams for which particular species are known to occur.

Subwatershed name	Stream name	Species present					Miles
Berry Creek	Berry Creek	ONCL		ONMY1	ONMY3		3.611
	Canyon Creek		ONTS1	ONMY1	ONMY3		3.180
Canyon City	Canyon Creek		ONTS1	ONMY1	ONMY3		6.380
Canyon Meadows	Canyon Creek	ONCL			ONMY3	SAFO	3.639
		ONCL		ONMY1	ONMY3		4.377
	Crazy Creek	ONCL			ONMY3		2.360
Fawn	Canyon Creek		ONTS1	ONMY1	ONMY3		4.178
		ONCL		ONMY1	ONMY3		1.582
		ONCL	ONTS1	ONMY1	ONMY3		1.099
	East Fork Canyon Creek	ONCL		ONMY1	ONMY3		0.159
Lower East Fork				ONMY1	ONMY3		1.230
	East Fork Canyon Creek	ONCL		ONMY1	ONMY3		4.657
	Wall Creek			ONMY1	ONMY3		2.931
Middle Fork Canyon Creek	Middle Fork Tributary 1	ONCL					0.493
	Middle Fork Tributary 2	ONCL		ONMY1	ONMY3		0.801
	Canyon Creek	ONCL		ONMY1	ONMY3		0.267
	Middle Fork Canyon Creek	ONCL		ONMY1	ONMY3		7.963
Sugarloaf	Canyon Creek	ONCL		ONMY1	ONMY3		4.846
	Middle Fork Canyon Creek	ONCL		ONMY1	ONMY3		0.871
Upper East Fork	Brookling Creek			ONMY1	ONMY3		1.349
	E Brookling Creek			ONMY1	ONMY3		1.400
	East Fork Canyon Creek	ONCL		ONMY1	ONMY3		3.498
	Skin Shin Creek			ONMY1	ONMY3		1.041
Vance Creek					ONMY3		0.129
	Vance Creek				ONMY3		0.928
	Vance Creek			ONMY1	ONMY3		3.092

3.1.1.1.2 Canyon City Subwatershed

Steelhead and redband trout, as well as juvenile Chinook salmon, are known to occur in the Canyon City subwatershed of Canyon Creek. There is no record of these species occurring in any other watercourses within the subwatershed. Reports from ODFW suggest juvenile Chinook salmon originate in the headwaters above Prairie City and primarily use the lower reaches of Canyon Creek as summer rearing habitat. In the summer of 2000, ODFW reported that a portion of the instream flow of Canyon Creek near Canyon City traveled sub-surface, which resulted in a fish kill that included many salmonids (Edwards, pers. comm. 2002).

3.1.1.1.3 Canyon Meadows Subwatershed

Cutthroat and redband trout are known to occur in Canyon and Crazy Creek. Brook trout, spawning August through September, compete for habitat resources with cutthroat and redband trout in Canyon Creek above Canyon Meadows (Reaches 11 - 14). As a result of opening the control gates of Canyon Meadows dam, it has been suggested that brook trout likely occur below the dam in Reach 10 (Edwards, pers. comm. 2002). Steelhead trout are currently limited to Reaches 9 and 10 of Canyon Creek, although they may have access to habitat farther upstream now that the floodgates of the dam are open. Steelhead may now have to compete for habitat with brook trout above and below Canyon Meadows dam.

3.1.1.1.4 Fawn Subwatershed

USFS data suggest juvenile Chinook salmon may rear as far upstream as Canyon Creek Reach 6 above the confluence with East Gulch. This also represents the downstream extent of cutthroat trout occurrence in Canyon Creek. Steelhead and redband trout are limited in occurrence to Canyon Creek only in the Fawn subwatershed.

3.1.1.1.5 Lower East Fork Subwatershed

Cutthroat, redband, and steelhead trout have been identified in the Lower East Fork subwatershed along the entire length of the East Fork of Canyon Creek. Steelhead and redband trout occur in Wall Creek Reach 3 to the confluence with the North Fork of Wall Creek and in Wall Creek Tributary 1 Reach 1 where gradient exceeds 15% and may limit fish presence.

3.1.1.1.6 Middle Fork Canyon Creek Subwatershed

Cutthroat, redband, and steelhead trout occur along approximately eight miles of Middle Fork Canyon Creek (Reach 6) as well as a 1-mile stretch of Middle Fork Canyon Creek Tributary 2, Reach 2. Fish presence in both reaches may be limited by low summer flows and gradients exceeding 15%.

3.1.1.1.7 Sugarloaf Subwatershed

Cutthroat, steelhead, and redband trout are limited to Canyon Creek and data available at this time indicate fish do not occur in any of the tributaries in the Sugarloaf subwatershed.

3.1.1.1.8 Upper East Fork Subwatershed

Cutthroat, redband, and steelhead trout occur in the East Fork of Canyon Creek just beyond the confluence with Miners Creek (Reach 5). Steelhead and redband trout occurrence extends into Brooklings Creek (Reach 2), Skin Shin Creek (Reach 1), and East Brooklings Creek (Reach 1) where presence is probably limited to low water flows.

3.1.1.1.9 Vance Creek Subwatershed

Fish distribution in the Vance Creek subwatershed, the westernmost subwatershed in the Canyon Creek watershed, is known only for Vance Creek itself. Steelhead and redband trout are known to occur throughout Reach 1. Redband are found upstream of Reach 1 for approximately one mile into Reach 2. The abnormally cool water temperatures measured in Vance Creek make it a potential candidate for fisheries restoration (see *Stream Temperature* section later in this chapter).

3.1.1.2 Summary of USFS Stream Survey Data

A total of 22.3 miles within 17 reaches of six streams were surveyed in the Canyon Creek watershed between 1993 and 1994 (SMART database, USFS) (Map 3.2). The reaches referred to here are reaches delineated by survey crews in the 1990s. These reaches are different from the Rosgen Level I reaches discussed below in the LWD and stream shade survey conducted as part of this analysis. A complete discussion on the Rosgen Level I survey is given in the *Physical Stream Characteristics* section of this chapter.

3.1.1.3 Fish Species

Four fish species were encountered in the stream surveys: sculpins, westslope cutthroat trout, steelhead/redband trout, and brook trout (Table 3.1). The highest diversity of fish species in the Canyon Creek watershed was found in the upper reaches of Canyon Creek (within the wilderness), with three of the four species represented (sculpins, cutthroat trout and brook trout) (Table 3.3). Crazy Creek likewise supported high diversity; electrofish data indicated the presence of steelhead/redband, sculpins, and cutthroat trout during the 1994 surveys.

3.1.1.4 Population Data (Presence and Abundance)

Six reaches within five streams were electrofished in 1993 and 1994 (Table 3.4). In the Canyon Creek Wilderness reaches, cutthroat trout were the most abundant (58% of the fish counted); brook trout were also prevalent, having 33% of the fish population, primarily in the lower wilderness reach (Canyon Wilderness Reach 1). In addition, juvenile sculpins comprised approximately 15% of the population structure of the wilderness reaches of Canyon Creek. The high population densities of brook trout with cutthroat trout indicate that the wilderness reaches of Canyon Creek as well as lower reaches are areas of concern for the maintenance and survival of cutthroat populations. Westslope cutthroat trout in Canyon Creek are considered a genetically unaltered species designated as a conservation population (Shepard et al. 2002). Cutthroat may at one time have been of the fluvial form. Due to habitat loss and degradation, they are now considered resident trout.

Cutthroat trout were also abundant in the surveyed wilderness reach of Middle Fork Canyon Creek (Reach 1) and its tributaries (T4 and T7). Crazy Creek had the only electrofishing data where steelhead/redband trout were found, although visual data from snorkel counts indicate steelhead/redband were also present in Canyon Creek, Vance Creek, and Middle Fork Canyon Creek (Table 3.5). Population structure was approximately equal in electrofished sections of Crazy Creek (Reach 1), with approximately 31% cutthroat and sculpin abundance and 38% steelhead/redband abundance.

Table 3.3. SMART reaches surveyed by USFS Level II (Hankin and Reeves) steam surveys where fish were present.

Reach name	Year surveyed	Beginning river mile	Ending river mile	Miles surveyed	Species richness
Canyon Wild: Reach #1	1994	24	24.6	0.6	3
Canyon Wild: Reach #2	1994	24.6	26.3	1.7	3
Canyon: Reach #1	1993	17	17.9	0.9	1
Canyon: Reach #2	1993	17.9	19.9	2	2
Canyon: Reach #3	1993	19.9	22.2	2.3	1
Canyon: Reach #5	1993	23	24	1	1
Crazy 94: Reach #1	1994	0	2.1	2.1	3
MF Canyon T4: Reach #1	1994	0	1.7	1.7	1
MF Canyon T7: Reach #1	1994	0	0.3	0.3	1
MF Canyon Wild: Reach #1	1994	6.6	8.2	1.6	1
MF Canyon: Reach #1	1993	0	2.6	2.6	1
MF Canyon: Reach #2	1993	2.6	3.9	1.3	2
MF Canyon: Reach #3	1993	3.9	5	1.1	2
MF Canyon: Reach #4	1993	5	6.2	1.2	1
MF Canyon: Reach #5	1993	6.2	6.6	0.4	1
Vance: Reach #1	1993	0.3	1	0.7	1
Vance: Reach #3	1993	2.2	3	0.8	1

Visual counts were conducted in the same years as electrofishing data were collected (Table 3.5). Brook trout were found in the upper reaches of Canyon Creek (Reach 5), just below the wilderness boundary. Visual counts of brook trout were quite high (323 adults), although a conclusion cannot be made from snorkeling data alone that the absence of native species is a function of the high brook trout numbers.

Table 3.4. Abundance of fish species obtained from electro-fishing from stream surveys, 1993 and 1994.

Reach name	Adult brook trout	Juvenile brook trout	Adult cutthroat trout	Juvenile cutthroat trout	Adult sculpins	Juvenile sculpins	Adult steelhead /redband	Juvenile steelhead /redband
Canyon Wild: Reach #1	11	38	4	12	0	16	0	0
Canyon Wild: Reach #2	0	2	13	52	0	8	0	0
Crazy 94: Reach #1	0	0	6	11	0	17	3	18
MF Canyon T4: Reach #1	0	0	8	24	0	0	0	0
MF Canyon T7: Reach #1	0	0	1	3	0	0	0	0
MF Canyon Wild: Reach #1	0	0	16	28	0	0	0	0

Steelhead/redband were present in all eight stream reaches snorkeled. Generally, more individuals were observed in the lower reaches of Canyon Creek, Middle Fork Canyon Creek, and Vance Creek than in the upper reaches. Cutthroat trout were observed in three reaches of the Middle Fork Canyon Creek (Reaches 3, 4, and 5). Snorkel counts are indicators for fish species only and do not provide as accurate population structure information as electrofishing.

Table 3.5. Abundance of fish obtained from visual snorkeling surveys from stream surveys during 1993 and 1994.

Reach name	Adult brook trout	Juvenile brook trout	Adult cutthroat trout	Juvenile cutthroat trout	Adult sculpins	Juvenile sculpins	Adult steelhead/ redband	Juvenile steelhead/ redband
Canyon: Reach #1	0	0	0	0	0	0	2	10
Canyon: Reach #2	0	0	0	0	1	0	8	0
Canyon: Reach #3	0	0	0	0	0	0	8	0
Canyon: Reach #5	323	0	0	0	0	0	0	0
MF Canyon: Reach #1	0	0	0	0	0	0	6	27
MF Canyon: Reach #2	0	0	0	0	3	0	6	9
MF Canyon: Reach #3	0	0	0	5	0	0	9	2
MF Canyon: Reach #4	0	0	7	27	0	0	0	0
MF Canyon: Reach #5	0	0	5	7	0	0	0	0
Vance: Reach #1	0	0	0	0	0	0	1	2
Vance: Reach #3	0	0	0	0	0	0	2	0

3.1.2 Riparian Vegetation Condition and Function

Riparian zones are narrow strips of land between the aquatic interface and drier, upland habitat types. Riparian zones are important to the maintenance and diversity of ecological processes within a watershed. Riparian vegetation is critical in moderating stream energy, providing key inputs for the maintenance of food webs, aiding in stream bank stability, creating structure for retention of coarse particulate organic matter and sediment storage, provide stream shade, and acting as a source for large wood inputs into streams (Beschta 1991). Especially in the arid west, stream shading is a key process that helps to moderate stream temperatures and provide instream cover and complexity for aquatic species (through visual competition or predation). LWD inputs are essential for creating instream habitat features (i.e., pools); the potential for a particular stream to maintain a constant influx of LWD (and hence maintain quality habitat features) is an important consideration in a long-term management plan. However, little data are known for stream shading or LWD recruitment for the Canyon Creek watershed. In this section of the watershed analysis, the near-term LWD recruitment (i.e., 10 to 20 years) was quantified and all Category 1 and 2 streams rated as to their current levels of stream shading.

3.1.2.1 Large Wood Debris (LWD) Near-Term Recruitment

Riparian zones are important habitats that have many critical functions. Riparian forests produce LWD that is recruited into a stream where it creates critical habitat features for aquatic species. The Malheur National Forest recognizes the role of LWD, and the Resource Land and Management Plan Amendment #29 specifies the number of pieces of LWD to be maintained for each mile of stream in certain ecotypes. In this analysis, the current condition of the riparian zones was rated with respect to near-term (10 to 20 years) functional LWD recruitment potential.

Near-term LWD recruitment potential was evaluated for most Category 1, 2 and 3 streams within the NFS lands of Canyon Creek watershed, based upon a modified method described by the Washington Department of Natural Resources (WADNR) Forest Practices Act (WFPB 1997) and the USFS Region 6 Level 2 Stream Survey protocols (Duck Creek Associates, Inc. *in prep*.) Evaluations were made of streams that would act as sources for LWD into known fish-bearing streams during periods of high flows and flood events. The stand-level data generated from photo-interpretation (PI) of 2001, color stereo-pair (1:12,000 scale) aerial photographs were used in this analysis. Using GIS, stream coverage data were buffered to 90 feet on both stream banks. Studies have shown that as much as 95% of in-channel LWD originate within 66 feet of the stream bank (Murphy and Koski 1989). This buffer distance was chosen because LWD recruitment is a function of hillslope gradient bordering the stream and of the height of a tree. Tree heights in the analysis area seldom exceed 100 feet, and allowances were made for any large trees that potentially could enter the stream. The PI vegetation data layer (PI data) and the stream buffer polygons were intersected using GIS, creating a new polygon layer for LWD recruitment. The PI data in these new polygons was classified using a rating system for tree size classes. Multiplying the size rating by the percent canopy closure of the stand created a score for the first two tree canopy layers from PI data. The lowest canopy layer (i.e., regenerating tree layer) was not used in this analysis because it was assumed it would not be a source of near-term functional wood recruitment into the stream. The scores of canopy layers 1 and 2 were summed to create a total score. Total polygon scores were classified as having High, Moderate, or Low near-term LWD recruitment potential based on their mean diameter and canopy cover (Table 3.6) (Duck Creek Associates, Inc. *in prep*).

3.1.2.1.1 LWD at the Watershed Scale

The analysis of near-term LWD recruitment potential across the watershed is summarized in Table 3.7. Based on the parameters used in this analysis, the riparian areas of each sub-watershed are dominated by stands that have a low potential for functional LWD recruitment in the near term. The Canyon City subwatershed was not included because no eligible streams were present on NFS lands. Vance and Fawn Creek riparian zones have the lowest potential of providing instream LWD in the near term on NFS lands. There are no riparian zone stands in Vance or Fawn Creek subwatersheds that have a high recruitment potential.

Table 3.6. Range of diameters and canopy closures in each near-term large wood debris recruitment potential class used in this analysis.

Recruitment potential	Range of scores	Example ranges of values in a recruitment potential class					
		L1 DBH	L1 CC	L2 DBH	L2 CC	Total % CC	Score
High	91 -155	21 – 32	35	9 - 15	25	60	155
		15 - 21	40	5 - 9	15	55	95
Moderate	61 - 90	21 - 32	20	9 - 15	15	35	90
		15 -21	22	5 - 9	18	40	62
Low	0 - 60	21 - 32	12	5 - 9	24	36	60
		5 - 9	5	1 - 5	4	9	5

In contrast, Berry Creek subwatershed has 39% of the riparian zone classified as a high recruitment potential. Lower and Upper East Forks of Canyon Creek have similarly high recruitment potential with 33% and 32%, respectively. The majority of the Berry, Upper, and Lower East Fork subwatersheds are within the Strawberry Mountain Wilderness Area. Since these riparian zones have been protected for some time, it could explain why the LWD recruitment potential is higher there than it is along streams outside the wilderness. In the *Synthesis and Interpretation* section of this analysis (*Chapter 5-6*), LWD is evaluated and compared for fish presence/absence and potential habitat.

3.1.2.1.2 LWD at the Subwatershed Scale

Our report of the remote near-term LWD study is broken down by reach. These reaches were delineated according to Rosgen Level I methodology. The results of the Level I survey are discussed in the *Physical Stream Characteristics* section of this chapter.

3.1.2.1.2.1 Berry Creek Subwatershed

Berry Creek subwatershed (Table 3.8) has a relatively high near-term LWD recruitment potential. Berry Creek and Deer Creek have over 60% of the evaluated area in high LWD. In contrast, approximately 88% of Cougar Creek has low LWD potential. Most of the reaches with high LWD potential are higher gradient streams that may transport LWD to downstream reaches.

3.1.2.1.2.2 Canyon Meadows Subwatershed

LWD recruitment potential for Canyon Meadows subwatershed is low (Table 3.9). Seven reaches have extremely low LWD recruitment potential. Canyon Creek Reaches 13 and 14 (above the dam) have moderate LWD potential. With the absence of large-diameter trees in the riparian zone, future LWD inputs may be a limiting factor in forming quality fish habitat.

Table 3.7. LWD recruitment potential determined from 1:12,000 aerial photography by subwatershed for Canyon Creek watershed.

Subwatershed name	Near term recruitment potential	Acres	Percent of subwatershed
Berry Creek	Low	106	40
	Moderate	58	21
	High	108	38
Canyon City	Low	5	100
Canyon Meadows	Low	294	88
	Moderate	40	11
	High	2	1
Fawn	Low	133	79
	Moderate	39	21
Lower East Fork	Low	119	51
	Moderate	105	45
	High	9	4
Middle Fork Canyon Creek	Low	255	70
	Moderate	85	23
	High	27	7
Sugarloaf	Low	85	59
	Moderate	20	14
	High	39	27
Upper East Fork	Low	135	40
	Moderate	147	43
	High	57	17
Vance Creek	Low	151	90
	Moderate	17	10
Total Acres		2,036	

Acres are calculated using GIS and are approximate.

Table 3.8. Near-term LWD recruitment potential for Berry Creek subwatershed.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod	% of low
Berry Creek	1	8.8	2.8	2.0	13.6	64.6	20.5	14.9
Berry Creek	2	26.8	2.6	9.2	38.7	69.4	6.8	23.8
Berry Creek	3	20.4	6.0	15.0	41.5	49.3	14.5	36.2
Berry Creek Tributary 1	1	15.6	10.9	12.7	39.3	39.7	27.8	32.4
Cougar Creek	1	16.2	9.2	33.8	59.3	27.4	23.9	87.5
Deer Creek	2	15.9		8.6	24.5	64.9	NA	35.1
Sheep Gulch	1	0.1	4.3	1.4	5.8	1.4	11.2	3.5
Sheep Gulch	2	4.1	15.8	4.5	24.4	16.8	64.8	18.5
Sheep Gulch unnamed tributaries	Not classified	0.2	6.5	19.3	26.0	0.7	25.2	74.2

Table 3.9. Canyon Meadows subwatershed LWD recruitment potential

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod	% of low
Big Canyon	Not Classified	0.0	0.0	41.04	41.0	0.0	0.0	100.0
Canyon Creek	9	0.0	0.0	29.61	29.6	0.0	0.0	100.0
Canyon Creek	10	0.0	2.5	51.87	54.3	0.0	4.6	95.4
Canyon Creek	11	0.0	0.0	18.08	18.1	0.0	0.0	100.0
Canyon Creek	12	0.0	0.4	24.22	24.6	0.0	1.5	98.5
Canyon Creek	13	1.605	8.6	10.02	20.2	7.9	42.6	49.5
Canyon Creek	14	0.0	12.3	46.62	58.9	0.0	20.9	79.1
Canyon Creek	Res.	0.666	16.1	20.59	37.4	1.8	43.1	55.1
Crazy Creek	1	0.0	0.0	35.07	35.1	0.0	0.0	100.0
Crazy Creek	2	0.0	0.0	17.33	17.3	0.0	0.0	100.0

3.1.2.1.2.3 Fawn Creek Subwatershed

A sufficient quantity of large diameter trees are not present in the riparian zone of Fawn Creek subwatershed to classify any reaches with a high LWD recruitment potential (Table 3.10). Only Road Gulch (Reach 1) is a moderate source of potential LWD recruitment. Based on this analysis, Fawn subwatershed is not expected to provide functional LWD to streams anytime in the next 20 years.

3.1.2.1.2.4 Lower East Fork Subwatershed

The majority of Lower East Fork subwatershed lies in the Strawberry Mountain Wilderness. Reach 2 begins immediately upstream of the wilderness boundary, yet Reach 2 is completely devoid of LWD recruitment potential (i.e., 100% of the reach was classified having a low LWD recruitment potential) (Table 3.11). Reach 3 is completely contained within the wilderness and is classified as having 76% low recruitment potential. Wall Creek and its tributaries have a moderate potential for LWD recruitment.

Table 3.10. Fawn Creek subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
Bear Gulch	1	0.0	5.3	33.3	38.6	0.0	13.6	86.4
Bear Gulch	2	0.0	0.0	0.8	0.8	0.0	0.0	100.0
Canyon Creek	6	0.0	0.0	3.2	3.2	0.0	0.0	100.0
Canyon Creek	7	0.0	0.0	0.1	0.1	0.0	0.0	100.0
East Gulch	1	0.0	0.0	16.6	16.6	0.0	0.0	100.0
East Gulch	2	0.0	0.0	37.9	37.9	0.0	0.0	100.0
Fawn Creek	1	0.0	0.6	27.0	27.6	0.0	2.1	97.9
Road Gulch	1	0.0	30.3	1.2	31.4	0.0	96.3	3.7
Sloan Gulch	1	0.0	0.2	12.8	12.9	0.0	1.2	98.8
W F East Gulch	1	0.0	0.0	31.8	31.8	0.0	0.0	100.0

Table 3.11. Lower East Fork Creek subwatershed LWD recruitment potential

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
E F Canyon Creek	2	0.0	0.0	19.2	19.2	0.0	0.0	100.0
E F Canyon Creek	3	0.0	11.5	36.5	48.0	0.0	24.0	76.0
N F Wall Creek	1	3.8	3.8	16.9	24.4	15.5	15.4	69.1
N F Wall Creek	2	0.0	8.3	5.1	13.4	0.0	62.0	38.0
Wall Creek	1	0.0	48.9	3.8	52.7	0.0	92.9	7.1
Wall Creek	2	0.0	4.2	0.5	4.7	0.0	88.4	11.6
Wall Creek	3	4.8	17.9	35.6	58.3	8.2	30.8	61.0
Wall Creek T1	1	0.0	10.5	1.7	12.2	0.0	86.1	13.9

3.1.2.1.2.5 Middle Fork Canyon Creek Subwatershed

Middle Fork Canyon Creek Reaches 1, 2, and 3 are outside of the wilderness boundary (Table 3.12). Reach 1 has the lowest recruitment potential (~94% of the reach) while Reach 2 is somewhat higher (~25% of the reach classified having high potential). Reaches 5 and 6, which are both within the wilderness boundary, have a higher recruitment potential than downstream reaches. Approximately 91% of Tributary 2 (Reach 1) has low recruitment potential. Generally, the trend for recruitment potential increases as elevation increases in the Middle Fork Canyon Creek subwatershed.

Table 3.12. Middle Fork Canyon Creek subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
M F Canyon Creek_T1	1	0.0	6.3	14.3	20.6	0.0	27.0	73.0
M F Canyon Creek_T2	1	0.0	1.1	10.1	11.2	0.0	8.8	91.2
M F Canyon Creek_T2	2	0.0	16.8	17.0	33.8	0.0	49.8	50.2
Middle Fork Canyon Creek	1	3.9	0.00	52.7	56.6	6.9		93.1
Middle Fork Canyon Creek	2	18.4	1.0	54.8	74.2	24.8	1.4	73.8
Middle Fork Canyon Creek	3	4.8	0.0	18.2	23.0	20.7	0.2	79.1
Middle Fork Canyon Creek	5	0.0	16.3	9.2	25.5	0.0	63.8	36.2
Middle Fork Canyon Creek	6	0.0	26.9	11.8	38.7	0.0	69.5	30.5
Middle Fork Canyon Creek	Not classified	0.0	17.2	66.9	84.0	0.0	20.4	79.6

3.1.2.1.2.6 Sugarloaf Subwatershed

Six streams were classified for LWD near-term recruitment potential (Table 3.13). Sugarloaf Gulch has over 70% high recruitment potential while Wickiup Creek Reach 1 has moderate potential for LWD recruitment. In contrast, four of the reaches in this subwatershed have an extremely low potential for LWD recruitment (100%) low recruitment potential. Generally, this subwatershed has a low potential to recruit LWD.

Table 3.13. Sugarloaf subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
Big Canyon	Not rated	0.0	0.0	2.8	2.8	0.0	0.0	100.0
Canyon Creek	7	0.0	0.0	0.9	0.9	0.0	0.0	100.0
Canyon Creek	8	1.3	0.9	4.6	6.8	19.5	13.4	67.1
Canyon Creek	9	0.0	0.0	10.1	10.1	0.0	0.0	100.0
Crawford Gulch	Not rated	0.0	0.0	4.7	4.7	0.0	0.0	100.0
Sugarloaf Gulch	1	35.6	4.4	10.3	50.2	70.9	8.7	20.4
W F Wickiup Creek	1	0.0	5.9	25.7	31.6	0.0	18.7	81.3
Wickiup Creek	1	2.0	4.7	0.4	7.1	28.4	65.4	6.2
Wickiup Creek	2	0.0	3.8	25.3	29.2	0.0	13.1	86.9

3.1.2.1.2.7 Upper East Fork Subwatershed

Brooklings Creek has a moderate potential to recruit LWD (Table 3.14). East Fork Canyon Creek Reach 5 has the highest potential to recruit LWD and potential decreases downstream in Reaches 4 and 3. Skin Shin and Tamarack Creeks generally have moderate potential. The potential for near-term recruitment is varied throughout the reaches yet generally moderate within the subwatershed.

Table 3.14. Upper East Fork subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
Brooklings Creek	1	0.0	5.4	1.0	6.4	0.0	84.2	15.8
Brooklings Creek	2	2.2	17.5	7.7	27.4	8.2	63.9	28.0
Brooklings Creek	3	3.4	8.1	17.1	28.6	12.0	28.3	59.7
E F Brooklings Creek	1	1.8	12.7	36.7	51.1	5.5	20.4	76.8
E F Canyon Creek	3	0.0	0.0	8.3	8.3	0.0	0.0	100.0
E F Canyon Creek	4	0.0	51.0	2.0	53	0.0	94	6.2
E F Canyon Creek	5	25.8	1.2	5.4	32.4	80	4	16
Skin Shin Creek	1	0.0	23.2	8.7	31.9	0.0	72.6	27.4
Skin Shin Creek	2	0.4	6.8	12.4	19.6	1.9	34.9	63.1
Tamarack Creek	1	0.0	5.0	9.6	14.6	0.0	34.1	65.9
Tamarack Creek	2	1.9	10.9	5.6	18.4	10.1	59.2	30.6
Miner's Creek	1	21.3	4.9	20.7	46.9	45.4	10.4	44.1

3.1.2.1.2.8 Vance Creek Subwatershed

This subwatershed offers little potential for near-term LWD recruitment (Table 3.15). Reach 1 has over 95% low recruitment potential classification, so this reach is expected to be limited for instream LWD in the near future. Reach 2 is divided evenly in its rating between low and moderate, while Reach 3 has over 90% classified as low potential. Both reaches of Bear Gulch have been classified as having low recruitment potential. Based on this analysis, Vance Creek subwatershed is not expected to produce or transport appreciable amounts of LWD in the near term.

Table 3.15. Vance Creek subwatershed LWD recruitment potential.

Stream name	Reach number	Acres high	Acres moderate	Acres low	Total acres	% of high	% of mod.	% of low
Bear Gulch	1	0.0	0.0	9.2	9.2	0.0	0.0	100.0
Bear Gulch	Not rated	0.0	0.0	2.1	2.1	0.0	0.0	100.0
Vance Creek	1	0.0	1.2	40.2	41.4	0.0	2.8	97.2
Vance Creek	2	0.0	5.8	4.9	10.7	0.0	54.2	45.8
Vance Creek	3	0.0	3.6	37.7	41.3	0.0	8.7	91.3
Vance Creek Tributary	Not rated	0.0	6.4	68.6	75.0	0.0	8.5	91.5

3.1.2.2 Shading by Tree Canopy Cover

Riparian stream shading is critical in regulating water temperature extremes, providing instream cover against predation, and acting as a source of nutrient inputs into the stream channel. Stream temperatures increase following disturbance to riparian vegetation (i.e., harvest, grazing, or fire) (Beschta and Taylor 1988). Given the high temperatures found within the Canyon Creek watershed and the importance of riparian vegetation in regulating extreme temperatures, it is important to identify stream reaches that are limited in shade and ultimately may be limited in providing quality instream habitat to fish species. In addition, it is known that shade from conifers and deciduous trees and shrubs functions differently. In winter, cold temperatures can be moderated by conifer shade acting as thermal cover.

In this study, the extent of vegetative shading on streams in the Canyon Creek watershed was determined, using protocols defined by the Oregon Watershed Enhancement Board (OWEB 1999). Stream shading was evaluated using recent color stereo-pair aerial photographs (2001, 1:12,000 scale) for most Category 1, 2, and 3 streams within the watershed. The photographs were taken in August, so it was assumed that this was the maximum shade canopy cover possible. Along the length of these streams, homogeneous polygons were delineated based upon shading and classified as having a high, moderate, or low shade potential. No distinction was made between conifers or deciduous shade in the analysis. Occasionally, comments were made on what type of vegetation created shade but was not part of the analysis. A high stream shade potential rating was assigned to polygons when the stream water surface and banks were not visible and canopy cover exceeded 70%. A moderate rating was assigned to polygons when at least one stream bank was evident and there was a 40% to 70% canopy cover. A low rating was assigned when both stream banks were visible and canopy cover < 40%. The role of topographic shading in contributing to cooler water temperature is recognized; however, the study was limited to riparian vegetation shade in this analysis. As in the LWD study, the reaches delineated by the Rosgen Level I analysis were used.

3.1.2.2.1 Stream Shading at the Watershed Scale

A total of 105 miles were evaluated for stream shading. Overall, 49 miles (47%) of streams had low potential shade, 39 miles (37%) had moderate shading, and approximatley 17 miles (16%) have a high stream shade potential. Berry Creek, Upper East Fork, and Lower East Fork subwatersheds have the highest vegetative cover, both in length and proportion of stream (Table 3.16). Approximately 12 miles of Fawn Creek have low shade potential (81%). Byram Gulch, Middle Fork Canyon Creek, and Sugarloaf are also low in shade potential (~70%, ~72%, and ~68%, respectively).

Table 3.16. Shade canopy classes given for each subwatershed in Canyon Creek.

	Stream miles in shade class				Percent of miles in a shade class		
Subwatershed	**Low**	**Mod.**	**High**	**Total miles of stream evaluated**	**Low**	**Mod.**	**High**
Berry Creek	5.06	5.79	4.58	15.43	32.79	37.54	29.67
Byram Gulch	0.74	0.32		1.07	69.79	30.21	0.00
Canyon City	1.61	3.97	0.22	5.80	27.76	68.38	3.86
Canyon Meadows	5.34	4.41	2.00	11.76	45.45	37.53	17.02
Fawn	11.80	2.37	0.40	14.57	81.00	2.92	13.78
Lower East Fork	4.48	4.63	3.95	13.05	34.31	35.45	30.24
Middle Fork Canyon Creek	8.67	2.50	0.91	12.08	71.78	20.72	7.50
Sugarloaf	6.48	3.10		9.59	67.64	32.36	0.00
Upper East Fork	1.42	9.48	4.28	15.19	9.36	62.43	28.21
Vance Creek	3.61	2.68	0.25	6.54	55.14	41.02	3.83

Shade canopy classes are shown in miles of stream per class and the percentage of stream miles each shade class represents for each subwatershed.

3.1.2.2.2 Stream Shading at the Subwatershed Scale

3.1.2.2.2.1 Berry Creek

Stream shade increases upstream in Berry Creek. Reaches 1 and 2 have low to moderate stream shade (i.e., one or both banks visible); Reach 3 has high levels of stream shade in approximately 28% of the reach (i.e., no banks are visible) (Table 3.17). A dramatic change in stream shading is present in Deer Creek between reaches. Reach 1 Deer Creek is almost entirely exposed (i.e., 98% low shade potential) and Reach 2 is heavily shaded for nearly two-thirds of the reach. Sheep Gulch is generally well shaded; >70% of both reaches of this stream have no more than one exposed bank (i.e., moderate to high shading potential). The two reaches of Canyon Creek that flow through Berry Creek subwatershed have a majority of the stream exposed to direct sunlight, especially Reach

3. Aside from Reach 3 Canyon Creek, the majority of the stream area of Berry Creek subwatershed is protected by vegetative cover.

Table 3.17. Shade classifications for Berry Creek subwatershed by number of miles and percent of total miles.

		Stream miles in shade class				Percent of stream in shade class		
Subwatershed	**Stream and reach**	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Berry Creek	Berry Creek: Reach #1	0.00	0.95	0.74	1.68	0.00	56.29	43.71
Berry Creek	Berry Creek: Reach #2	0.01	1.60	0.12	1.73	0.81	92.47	6.71
Berry Creek	Berry Creek: Reach #3	0.50	1.17	0.18	1.85	27.03	63.04	9.93
Berry Creek	Berry Creek_T1: Reach #1	2.12	0.02	0.44	2.58	82.28	0.79	16.93
Berry Creek	Canyon Creek: Reach #3	0.00	0.00	1.05	1.05	0.00	0.00	100.00
Berry Creek	Canyon Creek: Reach #4	0.31	0.46	1.00	1.78	17.53	25.97	56.50
Berry Creek	Deer Creek: Reach #1	0.02	0.00	0.77	0.79	2.35	0.00	97.65
Berry Creek	Deer Creek: Reach #2	0.87	0.22	0.44	1.53	57.05	14.17	28.78
Berry Creek	Sheep Gulch: Reach #1	0.39	0.73	0.31	1.42	27.15	51.11	21.74
Berry Creek	Sheep Gulch: Reach #2	0.36	0.65	0.00	1.01	35.37	64.63	0.00

3.1.2.2.2.2 Canyon City Subwatershed

The confluence of the John Day River with Canyon Creek occurs in the Canyon City subwatershed, and the entirety of Canyon Creek in this subwatershed is outside the Malheur National Forest boundaries. Ranches, farms, houses, and the towns of Canyon City and John Day border Canyon Creek as it flows through this subwatershed. Deciduous trees and shrubs create almost all vegetation shade. Reaches 1 and 2 have generally moderate shading; at least one bank is exposed for the Canyon Creek within this subwatershed (Table 3.18). Although moderate levels of stream shade are found in this subwatershed, other factors (i.e., instream flows, few deep pools, etc.) contribute to high water temperatures and hence the reliance upon dense stream shade becomes more important for the maintenance of aquatic species.

Table 3.18. Shade classifications for Canyon City subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Canyon Creek: Reach #1	0.22	1.60	1.22	3.05	7.35	52.50	40.15
Canyon Creek: Reach #2	0.00	2.37	0.37	2.74	0.00	86.44	13.56

3.1.2.2.2.3 Canyon Meadows Subwatershed

The reaches of Canyon Creek that flow through the Canyon Meadows subwatershed generally have low to moderate stream shading, with the exception of Reach 14 (Table 3.19). Approximately two-thirds of Reaches 9 through 13 has low shade potential (4.6 miles, or 63%) and 2.7 miles (37%) have moderate shade (i.e., one stream bank exposed). Vegetative cover in Reach 14 of Canyon Creek is considerably more; approximately two-thirds (1.4 miles) of this reach has moderate to high levels of stream shade. Likewise, both reaches of Crazy Creek have moderate to high levels of shade, with the entire length of Reach 2 having both banks shaded.

Table 3.19. Shade classifications for Canyon Meadows subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				**Percent of stream in shade class**		
Stream and reach	**High**	**Mod.**	**Low**	**Total miles**	**High**	**Mod.**	**Low**
Canyon Creek: Reach #10	0.00	0.66	1.71	2.37	0.00	28.03	71.97
Canyon Creek: Reach #11	0.00	0.00	0.83	0.83	0.00	0.00	100.00
Canyon Creek: Reach #12	0.00	0.92	0.19	1.11	0.00	82.89	17.11
Canyon Creek: Reach #13	0.00	0.88	0.00	0.88	0.00	100.00	0.00
Canyon Creek: Reach #14	1.12	0.28	0.68	2.08	53.68	13.36	32.96
Canyon Creek: Reach #9	0.00	0.24	1.89	2.13	0.00	11.08	88.92
Crazy Creek: Reach #1	0.11	1.43	0.04	1.58	6.79	90.58	2.63
Crazy Creek: Reach #2	0.78	0.00	0.00	0.78	100.00	0.00	0.00

3.1.2.2.2.4 Fawn Subwatershed

The majority of the Fawn subwatershed has low levels of stream shade. Of the approximately 6.9 miles of Canyon Creek within this subwatershed, 6.4 miles (approximately 93%) have both banks exposed with <40% shade (i.e., low shade potential) (Table 3.20). All reaches, with the exception of Fawn (Reach 1) and Vance Creek (Reach 1), have approximately 80% of their lengths with less than 40% vegetative cover. Both Fawn and Vance Creeks had slightly higher shading, with 50% to 70% of their reach lengths having at least one stream bank shaded (40% to 70% stream shade). At the subwatershed scale, stream shade may be a limiting factor for moderating stream temperatures for the Fawn subwatershed.

Table 3.20. Shade classifications for Fawn subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Bear Gulch: Reach #1	0.00	0.30	2.08	2.37	0.00	12.58	87.42
Canyon Creek: Reach #5	0.00	0.33	1.80	2.12	0.00	15.32	84.68
Canyon Creek: Reach #6	0.00	0.12	4.05	4.17	0.00	2.95	97.05
Canyon Creek: Reach #7a	0.00	0.00	0.54	0.54	0.00	0.00	100.00
East Gulch: Reach #1	0.00	0.00	0.78	0.78	0.00	0.00	100.00
East Gulch: Reach #2	0.00	0.49	0.98	1.47	0.00	33.37	66.63
Fawn: Reach #1	0.40	0.82	0.31	1.54	26.21	53.61	20.18
Vance Creek: Reach #1	0.00	0.08	0.02	0.10	0.00	76.76	23.24
W. Fork East Gulch: Reach #1	0.00	0.23	1.23	1.46	0.00	15.69	84.31

3.1.2.2.2.5 Lower East Fork

All reaches of East Fork Canyon Creek within this subwatershed have low to moderate quantities of stream shade (Table 3.21). North Fork Wall Creek (Reach 1) has approximately 99% and Wall Creek Reach 3 has 97% moderate shade potential (i.e., one exposed bank). North Fork Wall Creek Reach 2 and Wall Creek Reach 1 each have over 70% high shade potential, and both reaches are contained within the wilderness. In general, reaches within the wilderness boundaries have higher vegetative cover of near-stream vegetation than reaches outside the wilderness.

Table 3.21. Shade classifications for Lower East Fork subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
E. F. Canyon Creek: Reach #1	0.00	0.20	0.93	1.13	0.00	17.70	82.30
E. F. Canyon Creek: Reach #2	0.00	0.00	0.99	0.99	0.00	0.00	100.00
E. F. Canyon Creek: Reach #3	0.00	0.46	2.05	2.51	0.00	18.38	81.62
North Fork Wall Ck: Reach #1	0.01	1.07	0.00	1.09	1.28	98.72	0.00
North Fork Wall Ck: Reach #2	0.44	0.15	0.00	0.59	74.44	25.56	0.00
Wall Creek: Reach #1	1.92	0.38	0.41	2.70	70.98	13.97	15.05
Wall Creek: Reach #3	0.01	0.23	0.00	0.23	3.38	96.62	0.00
Wall Creek: Reach #4	1.31	1.27	0.00	2.58	50.88	49.12	0.00
Wall Creek_T1: Reach #1	0.25	0.87	0.11	1.23	20.66	70.69	8.65

3.1.2.2.2.6 Middle Fork Canyon Creek

Of the 8.6 miles of Middle Fork Canyon Creek (spanning 6 reaches), 6.6 miles (77%) have both banks exposed (i.e., low stream shade) and 1.7 miles (20%) have moderate degrees of stream shading (one bank exposed) (Table 3.22). Of these, Reach 4 has the highest shade levels (57% moderate to high stream shade), as does Reach 6 (100% moderate stream shade). Most of the lowest reaches of both tributaries to Middle Fork Canyon Creek have at least 40% vegetative cover. Reach 2 of Tributary 2 is limited in stream shade, with 1.3 miles (91%) having both banks exposed to direct sunlight.

3.1.2.2.2.7 Sugarloaf Subwatershed

Approximately 3.9 miles of the 4.0 miles (96%) of Canyon Creek that flow through this subwatershed have exposed stream banks (i.e., low stream shade) (Table 3.23). Sugarloaf Gulch is segmented with sections of moderate to low shade. The majority of Reach 1 of Wickiup Creek has moderate levels of stream shade; Reach 2 contrasts with 100% of its length having little to no stream shade. Overall, shade is a limiting factor for aquatic species in the Sugarloaf subwatershed.

Table 3.22. Shade classifications for Middle Fork subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
MF Canyon Creek: Reach #1	0.00	0.00	2.55	2.55	0.00	0.00	100.00
MF Canyon Creek: Reach #2	0.00	0.00	1.39	1.39	0.00	0.00	100.00
MF Canyon Creek: Reach #3	0.00	0.00	1.21	1.21	0.00	0.00	100.00
MF Canyon Creek: Reach #4	0.21	0.45	0.50	1.16	17.93	39.09	42.98
MF Canyon Creek: Reach #5	0.00	0.00	0.96	0.96	0.00	0.00	100.00
MF Canyon Creek: Reach #6	0.00	1.28	0.00	1.28	0.00	100.00	0.00
MF Canyon Creek_T1: Reach #1	0.54	0.30	0.72	1.56	34.53	19.30	46.17
MF Canyon Creek_T2: Reach #1	0.16	0.32	0.01	0.49	32.55	65.71	1.75
MF Canyon Creek_T2: Reach #2	0.00	0.14	1.34	1.47	0.00	9.25	90.75

Table 3.23. Shade classifications for Sugarloaf subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Canyon Creek: Reach #7b	0.00	0.17	2.81	2.98	0.00	5.70	94.30
Canyon Creek: Reach #8	0.00	0.00	1.05	1.05	0.00	0.00	100.00
Sugarloaf Gulch: Reach #1	0.00	1.46	1.06	2.51	0.00	57.94	42.06
WF Wickiup Creek: Reach #1	0.00	1.16	0.29	1.45	0.00	79.68	20.32
Wickiup Creek: Reach #1	0.00	0.32	0.03	0.35	0.00	91.99	8.01
Wickiup Creek: Reach #2	0.00	0.00	1.23	1.23	0.00	0.00	100.00

3.1.2.2.2.8 Upper East Fork

The Upper East Fork subwatershed lies completely within the wilderness. Of the 4.2 miles of East Fork Canyon Creek, 4.1 miles (approximately 97%) have moderate levels of vegetative cover (Table 3.24). Brooklings Creek has approximately 63% of its length with cover exceeding 70% (i.e., high shade). East Fork Brooklings, Skin Shin and Tamarack Creeks have moderate to high stream shade; Miner's Creek has moderate shading throughout its length (i.e., one stream bank exposed to direct sunlight). Overall, reaches in this subwatershed have adequate levels of stream shading for aquatic species.

Table 3.24. Shade classifications for Upper East Fork subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Brooklings Creek: Reach #1	0.00	0.27	0.00	0.27	0.00	100.00	0.00
Brooklings Creek: Reach #2	1.21	0.02	0.00	1.23	98.23	1.77	0.00
Brooklings Creek: Reach #3	0.53	0.00	0.74	1.27	41.54	0.00	58.46
E. Brooklings Ck: Reach #1	1.41	0.83	0.00	2.24	63.00	37.00	0.00
E. F. Canyon Creek: Reach #4	0.00	2.31	0.14	2.45	0.00	94.24	5.76
E. F. Canyon Creek: Reach #5	0.00	1.78	0.00	1.78	0.00	100.00	0.00
Miner's Creek: Reach #1	0.00	2.12	0.00	2.12	0.00	100.00	0.00
Skin Shin Creek: Reach #1	0.23	1.16	0.00	1.38	16.51	83.49	0.00
Skin Shin Creek: Reach #2	0.19	0.31	0.32	0.82	23.25	37.74	39.01
Tamarack Creek: Reach #1	0.71	0.06	0.01	0.79	90.77	8.22	1.01
Tamarack Creek: Reach #2	0.00	0.61	0.20	0.81	0.00	75.51	24.49

3.1.2.2.2.9 Vance Creek Subwatershed

The Vance Creek subwatershed has low to moderate stream shade throughout (Table 3.25). Of the 4.4 miles of Vance Creek, 1.9 miles (43%) have at least 40% vegetative cover and 2.2 miles (51%) have less than 40% cover. In general, stream shading on Vance Creek involves a patchwork of stream cover separated by areas of exposed stream channel. Reach 1 of Vance Creek has areas of dense vegetative cover, implying this reach is an important thermal refuge in the mid-reaches of Canyon Creek. Tributary 1 has generally mixed vegetative cover (low to moderate interspersed), and Tributary 2 of Vance Creek was completely exposed to direct sunlight. Despite the low to moderate shade cover, lower water temperatures are found in Vance Creek (see *Section 3.1.14*, *Chapter 3*). The lower temperatures may be attributed to the presence of springs and/or subsurface flow.

Table 3.25. Shade classifications for Vance Creek subwatershed by number of miles and percent of total miles.

	Stream miles in shade class				Percent of stream in shade class		
Stream and reach	**High**	**Mod**	**Low**	**Total miles**	**High**	**Mod**	**Low**
Vance Creek: Reach #1	0.25	0.65	1.17	2.07	12.11	31.53	56.36
Vance Creek: Reach #2	0.00	0.34	0.12	0.47	0.00	73.65	26.35
Vance Creek: Reach #3	0.00	0.89	0.91	1.81	0.00	49.52	50.48
Vance Creek_T1: Reach #1	0.00	0.79	0.51	1.30	0.00	60.94	39.06
Vance Creek_T2: Reach #1	0.00	0.00	0.90	0.90	0.00	0.00	100.00

3.1.3 Water Quality

This section of the report summarizes existing water quality information for the Canyon Creek Watershed. Water quality indicators may include several biological, chemical, and/or physical parameters. Data describing current water quality conditions in Canyon Creek were available (or could be inferred) for only two parameters – water temperature and fine sediment.

3.1.3.1 Water Temperature

The federal Clean Water Act (CWA) requires that states maintain a list of water bodies that are “water quality limited,” i.e., do not meet water quality standards. The listing of water quality limited streams is referred to as the “303(d) list.” In Oregon, the Department of Environmental Quality (ODEQ) is responsible for maintaining the state’s 303(d) list. The ODEQ periodically revises the 303(d) list. Currently, there is one stream segment within the Canyon Creek watershed that appears on the 1998 303(d) list and an additional segment proposed for inclusion on the 2002 303(d) list (Table 3.26 and Map 3.3).

Table 3.26. Water bodies within Canyon Creek watershed appearing on ODEQ 303(d) list.

List date	Water body name	Parameter/ season	Criteria	Beneficial uses	Supporting data
1998	Canyon Creek, RM 0 to 27.5	Summer water temperature	Rearing: 64 ° F	Anadromous fish passage Resident fish and aquatic life Salmonid fish spawning Salmonid fish rearing	BLM Data (Site above Canyon City): 7 day average of daily maximums of 66.5/68.4 with 26 of 87 days exceeding temperature standard (64) in 1993/1994; USFS (at Hwy 65): 7 day average of daily maximums of 66/85 with 5 of 97 days exceeding standard (64) in 1993/1994.
2002	East Fork Canyon Creek, RM 0 to 9.2	Summer water temperature	Rearing: 64 ° F	Salmonid fish rearing Anadromous fish passage	Laboratory Analytical Storage and Retrieval (LASAR) station #24046 at RM 2.6: In 2000, 43 days with 7 day average of daily maximums > 65 F (17.8 C).

Source: ODEQ 2002.

Additional water temperature data, available for 25 sites in the Canyon Creek watershed, were made available for this analysis by the USFS (Map 3.3 and Table 3.27). The data provided by the USFS was evaluated in the following manner: A seven-day moving average of the daily maximum temperature[5] was first calculated for each data record. The seven-day moving average of the daily maximum temperature was then compared to the ODEQ temperature criteria for salmonid rearing (64º F) and the number of days that the seven-day average exceeds the criteria was recorded. In addition, the National Marine Fisheries Service (NMFS[6] 1996) has established the following functional risk categories for summer salmonid rearing life-history stages:

- Functioning appropriately – 50 to 57 º F
- Functioning at risk – 57 to 64 º F
- Functioning at Unacceptable risk – > 64 º F

The seven-day moving average of the daily maximum temperature was also compared to the criteria identified by the NMFS, and the number of days that the seven-day average exceeds the criteria was also recorded. Time series plots of temperature data from all stations are included in Appendix 1 of this report, along with a summary of the maximum seven-day average temperature for each year and the number of days that the temperature criteria described above are exceeded.

[5] *OAR 340-04l-0006 (54) defines the numeric temperature criteria as the seven-day moving average of the daily maximum temperatures.*
[6] *Currently referred to as NOAA Fisheries.*

Table 3.27. Data availability for USFS water temperature monitoring within Canyon Creek watershed.

Map #	**Site description**	**Sampling year**								
		1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
1	E F Canyon Creek									
2	M F Canyon Creek @ Mouth									
3	M F Canyon Creek near Wilderness									
4	M F Canyon Creek, Sec. 30 (#1)									
5	M F Canyon Creek, Sec. 30 (#2)									
6	M F Canyon Creek, Sec. 36									
7	M F Canyon Creek above wetlands									
8	M F Canyon Creek below wetlands									
9	M F Canyon Creek blw narrow can.									
10	Canyon Creek above M F Canyon									
11	Canyon Creek above M F Canyon @ Draw									
12	Canyon Creek 1,000' below M F Canyon									
13	Canyon Creek above Big Canyon									
14	Canyon Creek below Crazy Creek									
15	Canyon Creek above Crazy Creek									
16	Crazy Creek Sec. 4									
17	Crazy Creek @ mouth									
18	Canyon Creek Sec. 31									
19	Canyon Creek Sec. 29									
20	Canyon Creek above Reservoir									
21	Canyon Creek @ Boundary									
22	Canyon Creek @ Wickiup Campground									
23	Canyon Creek below Wickiup Campground (at aspen exclosure)									
24	Canyon Creek below Road Gulch									
25	Vance Creek @ Boundary									

It is important when interpreting stream temperature data to consider the climatic conditions for the year in which the data were collected. If only a single year's worth of data is collected for a given site, and the year happens to be unusually hot, then the data may not be representative of normal conditions[7]. Air temperature data from the John Day climate station (see *Chapter 1* of this report for station location) were used to evaluate how climatic conditions during the years of data collection compared to long-term conditions. A seven-day moving average maximum air temperature was calculated for the period of record (1961 to present) at the station. The maximum value for each year was recorded, and a percentile was calculated for each data point Figure 3.1). For the years having stream temperature data, three are below average (1995, 1997, 1999; Figure 3.1) and six are above average (1994, 1996, 1998, 2000, 2001, 2002; Figure 3.1). The year 2002 had the highest seven-day moving average maximum air temperature on record at the John Day station.

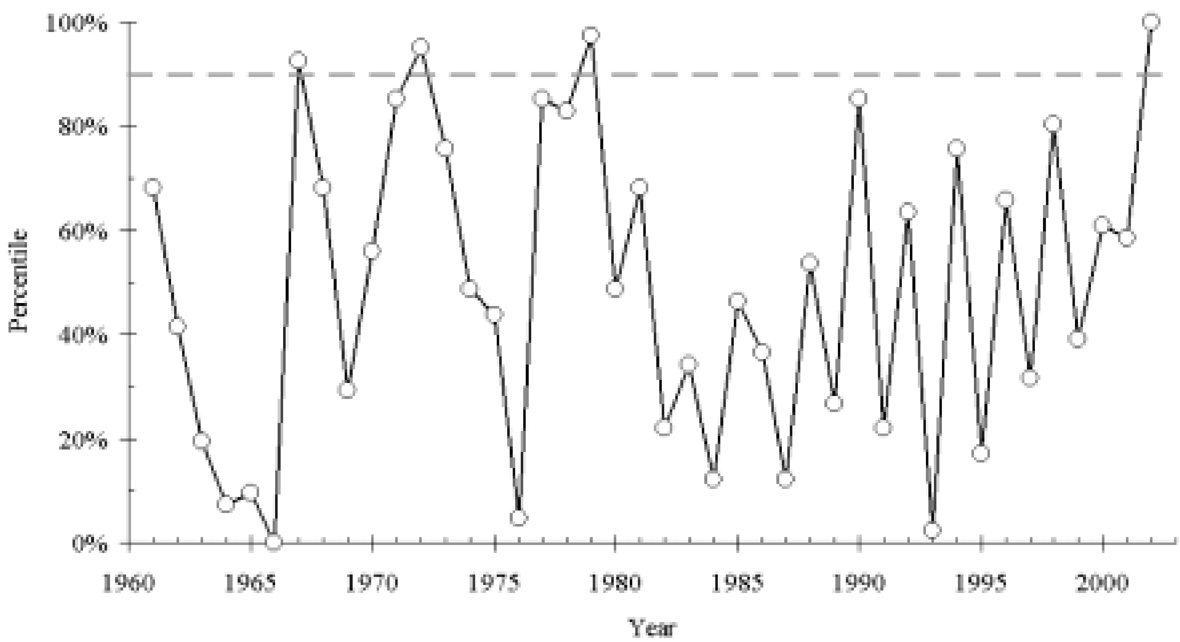


Figure 3.1. Percentiles for annual maximum seven-day average daily maximum air temperature at John Day weather station.

Twenty of the 25 streams monitored by the USFS exceed the ODEQ temperature criteria for salmonid rearing (i.e., 64º F) in most years (Figure 3.2). These streams would also be categorized as "Functioning at Unacceptable risk" using the NMFS (1996) criteria. Those stations that do not exceed the criteria are stations #16 – Crazy Creek in Section 4, #17 –

[7] *OAR 340-041-0605 recognizes these extreme conditions by stating "An exceedance of the numeric criteria… will not be deemed a temperature standard violation if it occurs when the air temperature during the warmest seven-day period of the year exceeds the 90th percentile of the seven-day average daily maximum air temperature calculated in a yearly series over the historic record."*

Crazy Creek at mouth, #19 – Canyon Creek in Section 29, #20 – Canyon Creek above Reservoir, and #25 – Vance Creek at the Forest Boundary (Figure 3.2). All five stations that do not exceed the criteria are located in headwater areas. It is interesting to note that both station #1 – East Fork Canyon Creek, and station #3 – Middle Fork Canyon Creek near wilderness, are located either within or close to the boundary of the designated wilderness area, yet both would be rated as "Functioning at Unacceptable risk" using the NMFS criteria (1996).

Three of the five streams that did not fall within the "Functioning at Unacceptable risk" criteria, do fall within the "Functioning at risk" criteria (Figure 3.2). These stations are #17 – Crazy Creek at mouth, #19 – Canyon Creek in section 29, and #20 – Canyon Creek above Reservoir. Only stations #16 – Crazy Creek in section 4, and #25 – Vance Creek at the Forest Boundary meet the "Functioning appropriately" criteria (Figure 3.2).

Regression analysis was used to determine the relationship between the annual maximum seven-day moving average of the daily maximum water temperature ($\mathbf{T_{max}}$) and the environmental variables most likely to affect water temperatures. The variables considered in the regression analysis were:

Site elevation (E). The elevation at the stream temperature monitoring site (in units of feet; determined from digital elevation model data)

Riparian shade (S). Riparian shade levels (expressed as a decimal) for the 1,000 feet of stream located immediately upstream of the temperature monitoring site. Sullivan et al. (1990) found that riparian shade levels in the 1,000-foot reach immediately upstream of a given point had the greatest influence on stream temperatures. Midpoint shade values were used for each shade category (i.e., areas classified as currently having "high" riparian shade [>70%] were assigned a value of 0.85; areas with a "moderate" shade rating [40% to 70 %] were assigned a value of 0.55; and areas with a "low" shade rating [< 40%] were assigned a value of 0.2). A length-weighted approach was used to estimate a composite shade value in situations where shade conditions change within the 1,000-foot reach.

Mean annual air temperature (T_{air}). Groundwater temperature may be approximated by the mean annual air temperature (Sullivan et al. 1990). Mean annual air temperature (in degrees F) at the Starr Ridge SNOTEL site were used to capture year-to-year variability in groundwater temperatures.

Mean annual streamflow (Q). Mean annual streamflow is another variable useful in evaluating year-to-year differences in $\mathbf{T_{max}}$. In general, maximum water temperatures will be higher in years with low streamflow and lower in wetter years. The closest active stream gage to Canyon Creek that has no data gaps between 1994 to 2002 is USGS gage # 14046000 – North Fork John Day River at Monument. Mean annual streamflow (cfs) from the North Fork gage was used in the regression model.

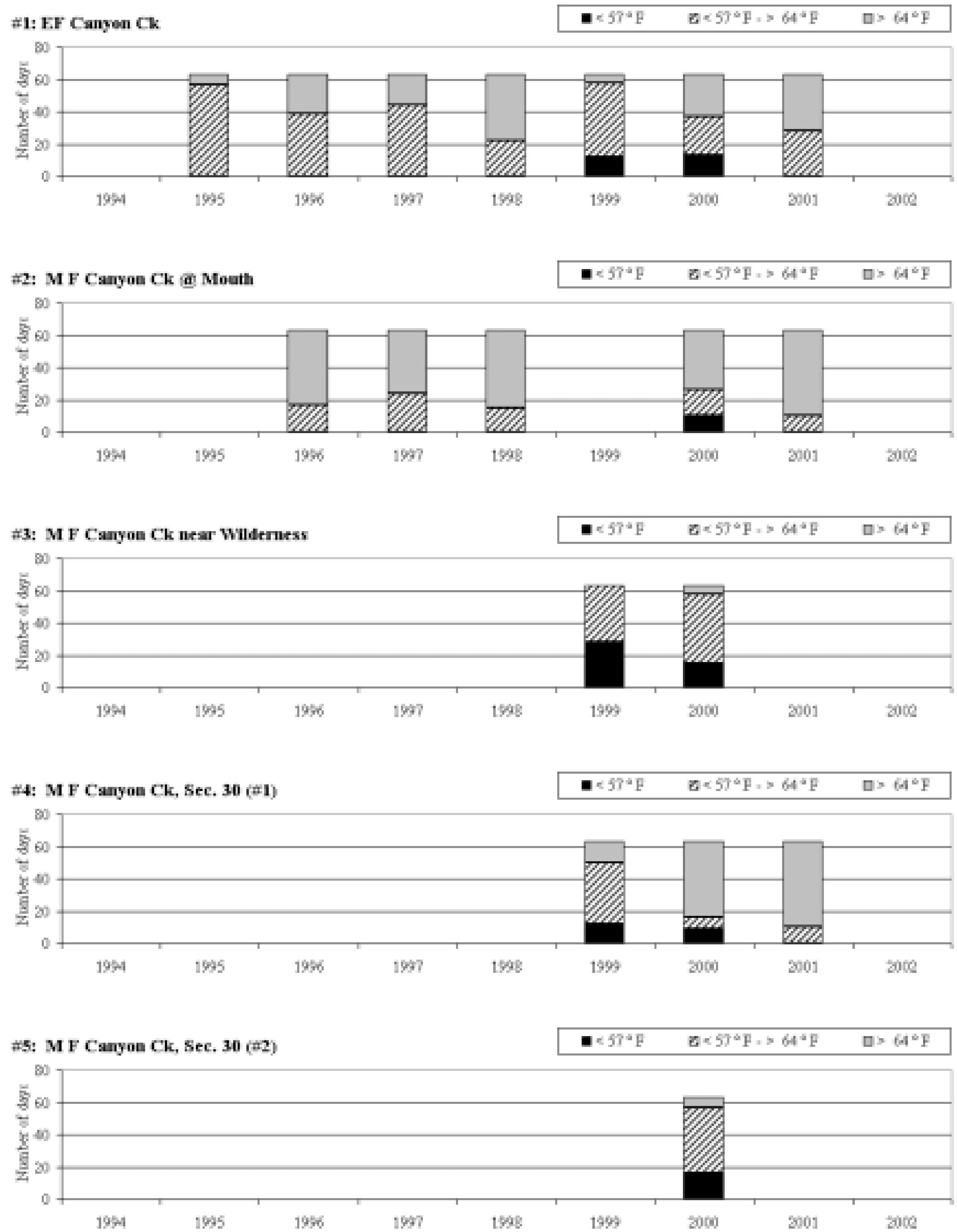


Figure 3.2. Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 º F (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

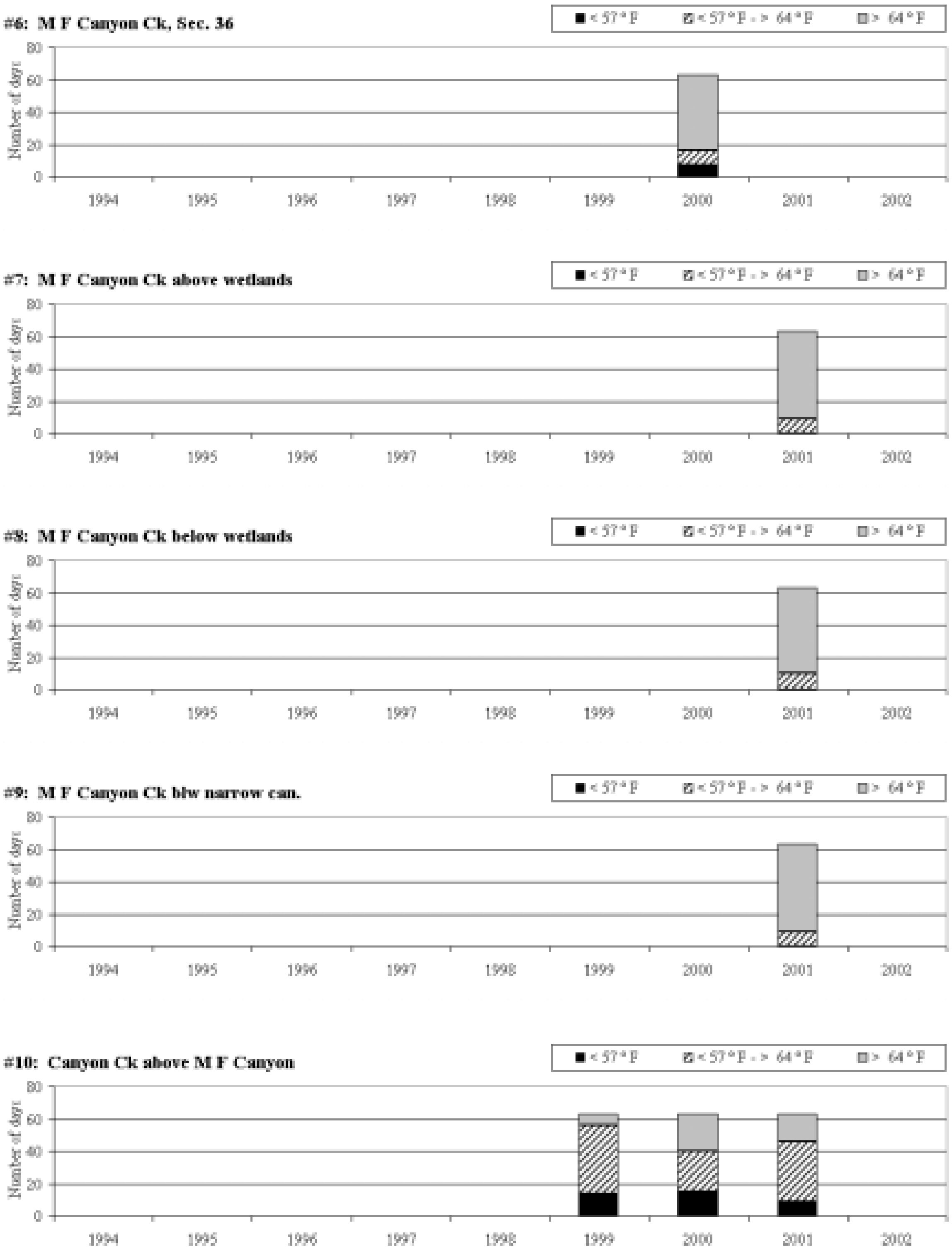


Figure 3.2 (continued). Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 ºF (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

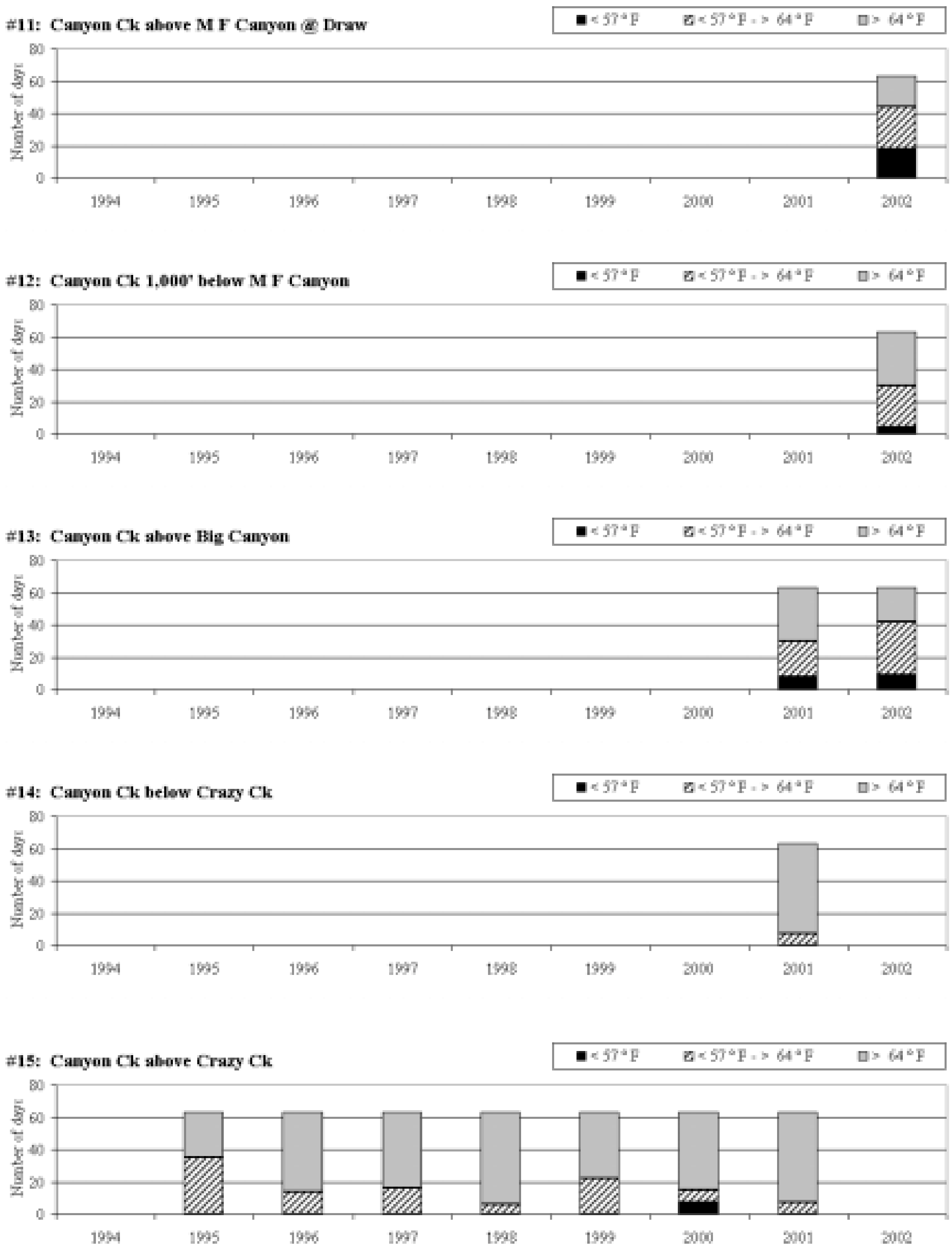


Figure 3.2 (continued). Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 ºF (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

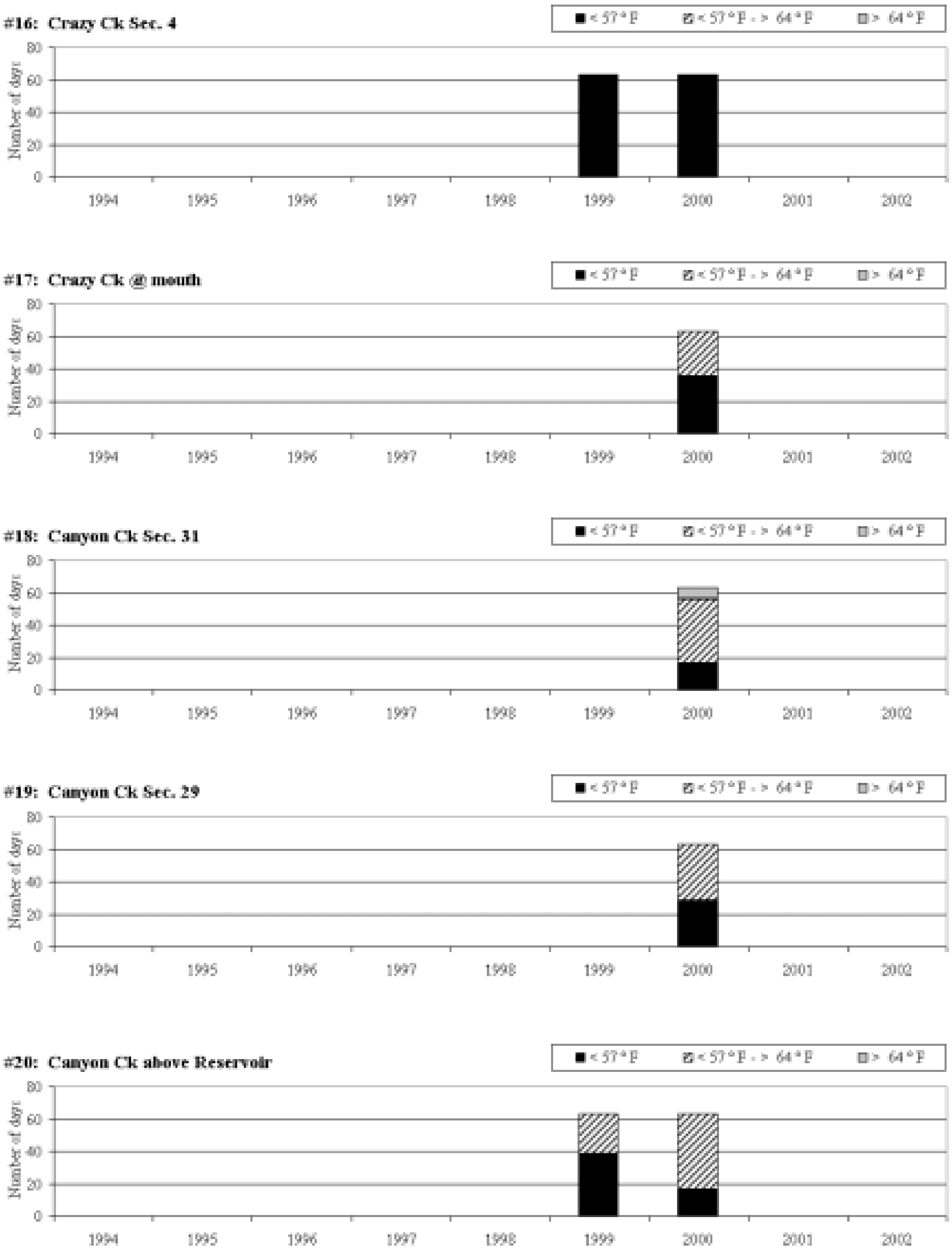


Figure 3.2 (continued). Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 ºF (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

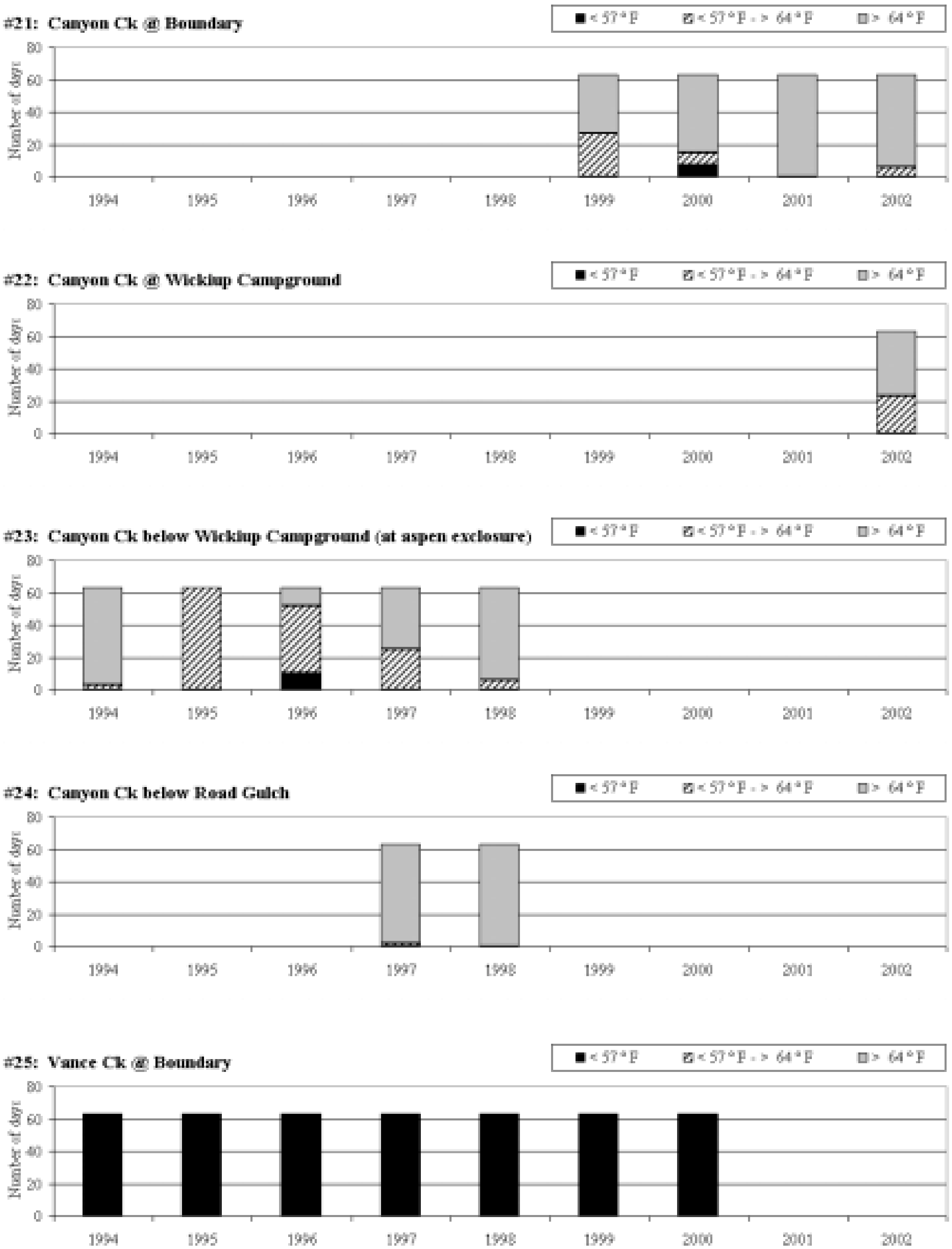


Figure 3.2 (continued). Frequency of days during the July 15th – September 15th period when the maximum seven-day moving average of daily maximum temperature is < 57 ºF (i.e., functioning appropriately), 57 to 64 º F (functioning at risk), and > 64 º F (functioning at unacceptable risk).

Distance from watershed divide (D). The final variable used in the regression analysis was distance from watershed divide (in units of miles). Distance from the watershed divide provides an index of the time that water has been exposed to ambient air temperatures. The implication is that streams that have a shorter distance to the watershed divide would be expected to have lower water temperatures

A stepwise approach was taken to eliminate those variable from the regression equation that were not statistically significant at the $p \leq 0.05$ level. The final form of the equation was:

$$T_{max} = -22.441\mathbf{S} - 0.00367\mathbf{Q} + 0.976\mathbf{D} + 70.677$$

(adjusted $R^2 = 0.811$, $n = 63$, all variables significant at $p \leq 0.00001$)

The fact that site elevation and mean annual air temperature (as a surrogate for groundwater temperature) were not statistically significant in the final equation does not necessarily mean that these are not important variables driving stream temperatures at any given site. The reason these variable were not statistically useful is probably due to the narrow range of variability in site elevations (all were between approximately 4,000 and 5,250 feet elevation) and mean annual air temperature (range from 42 to 44° F for the seven-year period).

The regression results presented above explained over 80% of the variability in T_{max} at the 25 temperature monitoring stations in the Canyon Creek watershed. The residual variability (Figure 3.3) was further examined to ascertain if there are any time-trends in the data or any additional site-specific patterns. No time trends were apparent within the residual variation. This is not surprising given the short-duration (seven years or less) of the data sets. The presence of a time-related trend in the residuals would suggest either recovery (in the case of a decreasing trend) or some disturbance that is decreasing the amount of shade or stream flow (in the case of an increasing trend).

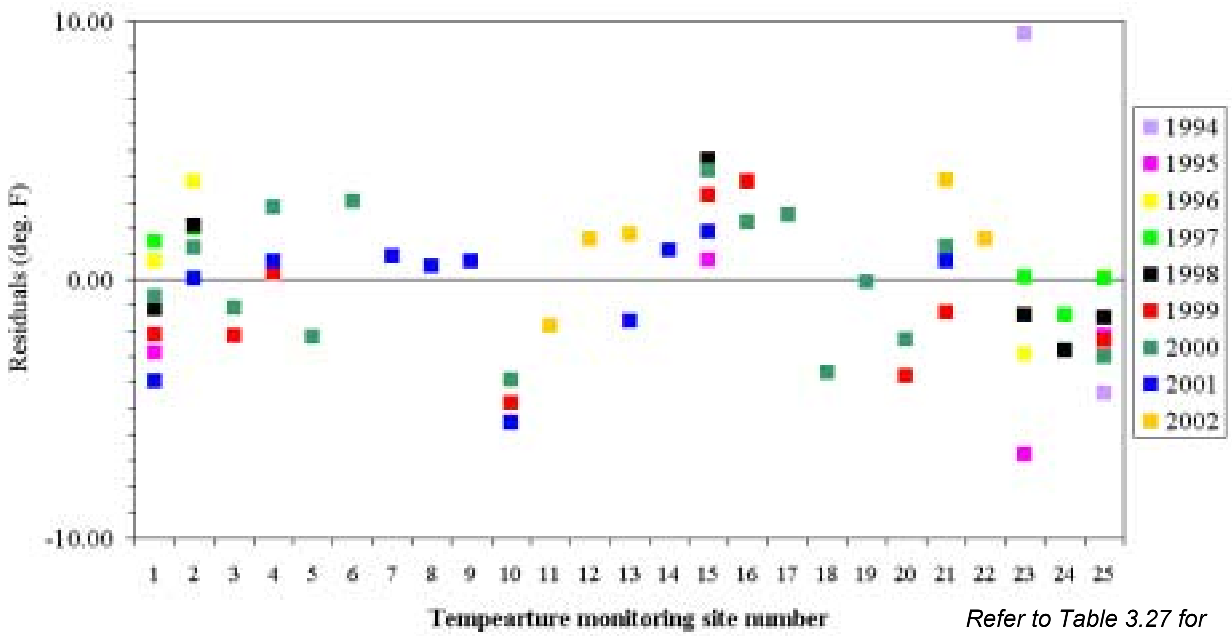
Examination of the residuals in Figure 3.3 indicate that there are several sites (e.g., 3, 10, and 25) where T_{max} is consistently cooler than expected, and other sites (e.g., 2 and 15) where T_{max} is consistently warmer than expected. These patterns suggest that there are site specific conditions that are not adequately accounted for in this regression analysis. For example, these sites may have a disproportionately large or small groundwater contribution to the total stream volume. Another item of interest in the residual variation is the how tight the residuals are clustered. The large year-to-year variation in the residuals at site #23 may be indicative of a large site-specific disturbance (e.g., removal of a beaver dam upstream). Despite the limitations, several points can be drawn from the analysis discussed above:

1. Stream temperatures are highly responsive to differences in riparian shade levels. Reductions in stream shade levels, through some type of riparian disturbance, will be

expected to increase stream temperatures. Conversely, actions that lead to an increase in riparian shading are expected to result in decreased stream temperatures.

2. Stream temperatures are sensitive to both natural and human-caused variations in summertime stream flow. Low base flow conditions, brought about by climatic conditions or human-related activities, will likely result in increased stream temperatures

3. Inherent differences in site conditions (e.g., elevation, distance from watershed divide, etc.) must also be considered when evaluating T_{max}.



Refer to Table 3.27 for description of site locations.

Figure 3.3. Residual variability from stream temperature regression model.

3.1.3.2 Sedimentation

3.1.3.2.1 Road-generated

Road-generated sediment can be a large source of sedimentation in some watersheds, particularly when the overall density of roads is high, the roads see frequent use, or the roads are located in steep terrain. The USFS has recently completed a road inventory within the Canyon Creek watershed (USFS 2002a) (Map 3.4). Results from this survey were used to qualitatively assess current road-related sedimentation concerns.

Overall road length and road density are summarized in Table 3.28. There are approximately 315 miles of roads within the Canyon Creek watershed, 204 miles of which are administered by the USFS. Road density for the entire road system ranges from 0.0 miles/mi^2 (i.e., no roads) in the Upper East Fork subwatershed to 5.2 miles/mi^2 in the Vance Creek subwatershed and density is 2.7 miles/mi^2 for the watershed overall. Road density for roads administered by the USFS ranges from 0.0 miles/mi^2 in the Upper East Fork and Berry Creek subwatersheds to 4.2 miles/mi^2 in the Vance Creek subwatershed and is 1.8 miles/mi^2 for the watershed overall.

Table 3.28. Road length and density by subwatershed within Canyon Creek watershed.

Subwatershed	***Total miles road***	***Subwatershed area (mi^2)***	***Road density: all roads (mi/mi^2)***	***Total miles USFS road***	***Road density: USFS roads (mi/mi^2)***
Berry Creek	22.1	15.1	1.5	0.0	0.0
Byram Gulch	1.5	1.4	1.1	0.7	0.5
Canyon City	38.4	8.8	4.4	0.1	0.0
Canyon Meadows	53.3	13.5	3.9	50.7	3.7
Fawn	81.9	21.9	3.7	54.2	2.5
Lower East Fork	2.0	12.1	0.2	1.2	0.1
Middle Fork Canyon Creek	21.9	11.1	2.0	21.9	2.0
Sugarloaf	55.1	11.6	4.8	44.4	3.8
Upper East Fork	0.0	12.6	0.0	0.0	0.0
Vance Creek	38.5	7.4	5.2	31.0	4.2
Entire Watershed	314.7	115.6	2.7	204.2	1.8

USFS roads within the Canyon Creek watershed having identified erosion concerns that are within 60 meters (~200 feet) of fish-bearing streams are summarized in Figure 3.4 (Map 3.5). Approximately half the USFS road system is open in the Fawn Creek subwatershed; two-thirds of the road system is open in the Sugarloaf, Vance Creek, and Middle Fork Canyon subwatersheds; 80% of the roads are open in the Canyon Meadows subwatershed; and 100% of the roads are currently open in the Lower East Fork subwatershed.

The recently completed USFS road inventory for the Canyon Creek watershed (USFS 2002a) identified road segments that have problems with respect to surface erosion. Twenty-seven miles of USFS roads were identified as currently having an erosion concern (Table 3.29). The majority of these roads are located within the Canyon Meadows, Sugarloaf, and Vance Creek subwatersheds.

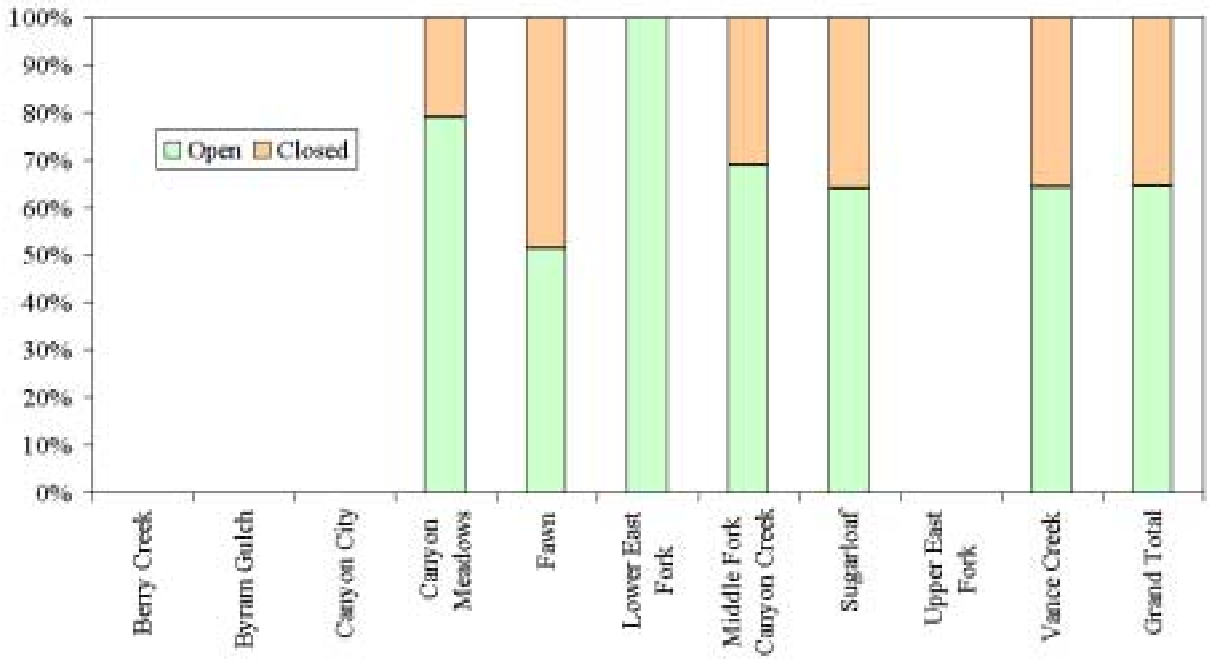


Figure 3.4. Summary of current USFS road closure status by subwatershed within Canyon Creek watershed.

Table 3.29. Summary of road length with identified erosion concerns, and road length identified for possible decommissioning.

Subwatershed	***Miles of USFS road with identified erosion concern***	***Miles of USFS road with identified erosion concern within 60 meters of fish-bearing stream***	***Miles of USFS road identified for possible decommissioning***
Berry Creek			
Byram Gulch			
Canyon City			
Canyon Meadows	8.3	1.1	8.9
Fawn	2.2	0.1	11.1
Lower East Fork			
Middle Fork Canyon Creek	2.1	0.3	2.8
Sugarloaf	7.9	2.0	4.8
Upper East Fork			
Vance Creek	6.7	0.3	5.5
Entire watershed	27.2	3.8	33.1

Further analysis of this data set was performed to pinpoint roads that may contribute considerable amounts of sediment to streams. It is generally accepted that the greatest amount of sediment will be delivered from road segments that are within 60 meters (~200 feet) of a stream (OWEB 1999, WFPB 1997). This 60-meter distance was used as an approximate break point to identify the majority of the road segments likely to contribute considerable amounts of sediments to the stream system. A total of 3.8 miles of USFS roads were identified as currently having erosion concern and are located within 60 meters of fish-bearing streams. The majority (2.0 miles) of these roads are within the Sugarloaf subwatershed.

An alternative approach was also used to identify road segments that may be delivering large amounts of sediment to the stream system. Information on road surfacing types is available as an attribute in the USFS GIS data coverage for the watershed. Also available are the erodibility ratings for the underlying soil polygons. For the purposes of this analysis, it was assumed that the erosion potential for native surfaced roads is represented by the erodibility rating of the underlying soil. Native-surfaced USFS roads are shown in Map 3.6. The distribution of native-surfaced roads by underlying soil erodibility class is summarized in Table 3.30

Table 3.30. Miles of native-surfaced road by underlying soil erosion class within Canyon Creek watershed.

	Soil erosion class					
Subwatershed	***Low***	***Low-Mod***	***Moderate***	***Mod-High***	***High***	***Very High***
Berry Creek	-	-	-	-	-	-
Byram Gulch	-	-	-	-	-	0.7
Canyon City	-	-	-	-	-	-
Canyon Meadows	-	2.0	21.0	12.7	-	3.1
Fawn	-	1.4	14.8	9.5	1.5	15.8
Lower East Fork	-	-	-	-	0.3	-
Middle Fork Canyon Creek	0.5	5.6	0.5	7.2	1.6	1.4
Sugarloaf	-	0.5	16.9	5.5	-	12.5
Upper East Fork	-	-	-	-	-	-
Vance Creek	-	0.4	3.2	8.0	-	10.5
Entire watershed	**0.5**	**9.8**	**56.4**	**42.9**	**3.4**	**44.1**

Only a very small proportion of the native-surfaced USFS roads within the watershed occur on areas where the soil erodibility class is rated as either Low (0.5 miles of road, or 0.3% of the total road length; Table 3.30) or Low-Moderate (6% of the total road length). The majority of the road length falls within the Moderate (36% of the total road length) and Moderate-High (27% of the total road length) classes. Only a small proportion of the native-surfaced USFS roads occur on areas of High soil erosion potential (2% of the total road length); however, 28% of the total road length occurs on soils classified as having Very High erosion potential.

As in the preceding section, a second analysis was performed for those road segments that are located within 60 meters of fish-bearing streams (Table 3.31). A total of 3.6 miles of USFS roads were identified as being located within 60 meters of fish-bearing streams. Approximately one mile of these road segments are located on soils classed as having Very High erosion potential, and these are located within the Middle Fork Canyon Creek and Sugarloaf subwatersheds.

Table 3.31. Miles of native-surfaced road within 60 meters of fish-bearing streams by underlying soil erosion class within Canyon Creek watershed.

	Soil erosion class					
Subwatershed	***Low***	***Low-Mod***	***Moderate***	***Mod-High***	***High***	***Very High***
Berry Creek	-	-	-	-	-	-
Byram Gulch	-	-	-	-	-	-
Canyon City	-	-	-	-	-	-
Canyon Meadows	-	0.3	0.1	0.1	0.1	-
Fawn	0.0	-	-	-	0.2	-
Lower East Fork	-	-	-	0.1	-	-
Middle Fork Canyon Creek	-	0.9	0.4	-	-	0.2
Sugarloaf	-	-	0.3	-	-	0.8
Upper East Fork	-	-	-	-	-	-
Vance Creek	-	-	-	-	-	-
Entire watershed	0.0	1.2	0.8	0.1	0.3	1.0

The USFS road inventory for the Canyon Creek watershed (USFS, 2002) identified road segments that may be candidates for decommissioning[8]. Roads identified for possible decommissioning are shown in Map 3.7 and summarized in Table 3.29. Approximately 33 miles are identified for possible decommissioning within the watershed; located within the Fawn, Canyon Meadows, Vance Creek, Sugarloaf, and Middle Fork Canyon Creek subwatersheds.

One final item from the USFS road inventory for the Canyon Creek watershed (USFS 2002a) is the maintenance concerns identified by road segment. Maintenance concerns

[8] *The road segments identified for possible decommissioning discussed here are based solely on field-review by District personnel. A road analysis must be completed before any decision is made as to which road segments (if any) are recommended for decommissioning*

are summarized for the entire watershed in Figure 3.5. The five primary maintenance concerns include blading, brushing, culvert installation/maintenance, ditch installation/ maintenance, and waterbar installation/ maintenance. With the exception of brush removal, all these maintenance concerns, if implemented, will tend to reduce road-related sediment generation.

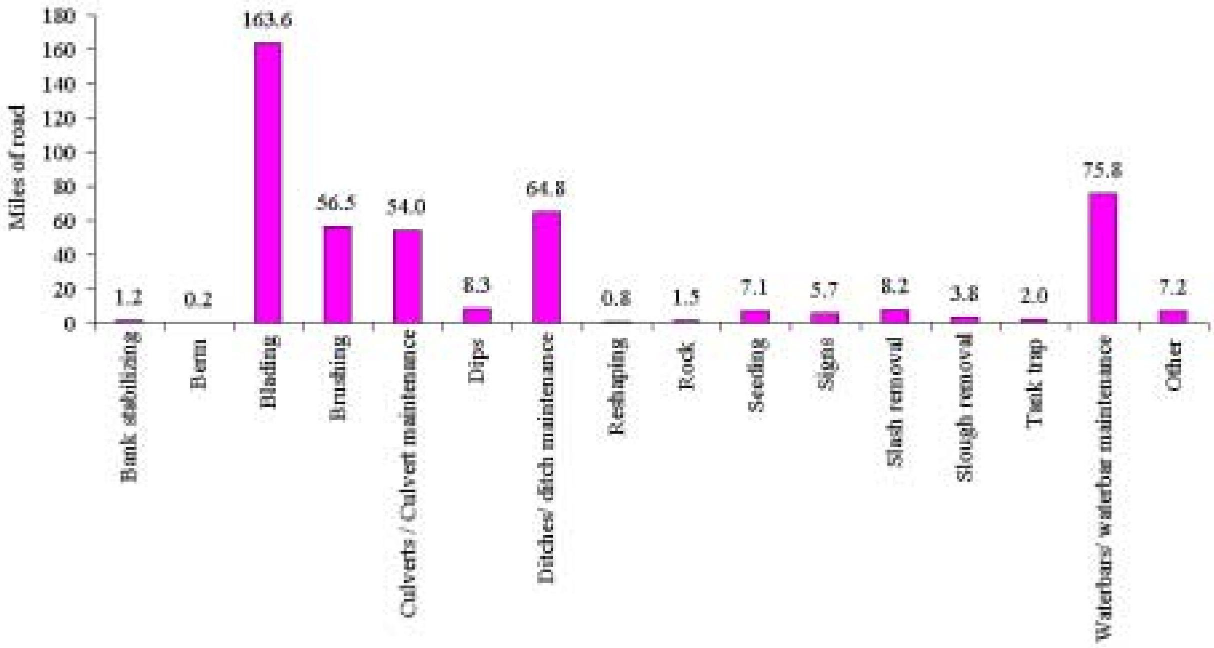


Figure 3.5. Miles of road within Canyon Creek watershed identified by maintenance concern. Source: USFS (2002).

In summary, although no quantitative evaluation of sediment-generation from roads is available for the Canyon Creek watershed, the following points can be made based on the qualitative metrics used in this evaluation:

Road density. Road density is generally accepted as being positively correlated with sedimentation (USFS 1996). However, recent studies from eastern Washington (Schiess and Krogstad 2000) indicate that road density alone is a poor indicator of sediment delivery to streams and that other factors (e.g., road surfacing and use) may be far more important. In a relative sense, road density in the Canyon Creek watershed can be used to identify those subbasins where road-related sediment may be of the most concern; Vance Creek, Sugarloaf, Canyon City, Canyon Meadows, and the Fawn subwatersheds all have road densities of from 3.7 to 5.2 miles/mile^2 (Table 3.28).

Road use. Sediment production and delivery is positively correlated with road use, particularly during wet weather (WFPB 1997). While no data exists on current use levels for roads in the watershed, information on closure status (Figure 3.4) indicates that most roads are open for use.

Identified erosion concerns. Recent road inventories conducted by the USFS indicate that a very small proportion of the roads within the watershed (27 miles of the approximately 200 miles of USFS roads; Table 3.29) currently have any erosion concern; and of the roads in close proximity to streams only four miles of road currently have an identified erosion concern (Table 3.29). Problem roads are located primarily in the Sugarloaf and Canyon Meadows subwatersheds.

Erosion concerns based on native surfaced roads. Additional analysis was performed to evaluate the distribution of native-surfaced roads within areas of high soil erodibility. Native-surfaced roads located on soils with a Very High erodibility classification are found primarily in the Fawn, Sugarloaf, and Vance Creek subwatersheds (Table 3.30). Native-surfaced roads located within 60 meters of fish-bearing streams, and on soils with a Very High erodibility classification, are found only in the Middle Fork Canyon Creek and Sugarloaf subwatersheds (Table 3.31).

Road decommissioning. Approximately 33 miles of USFS roads are identified for possible decommissioning within the Canyon Creek watershed (Table 3.29). The majority of the roads identified for possible decommissioning (Map 3.7) are the roads identified as having erosion concerns (Map 3.8).

Identified maintenance concerns. Implementation of the primary maintenance concerns identified in the recent road inventory will tend to reduce road-related sediment generation

The results presented here reflect the professional judgment of district personnel who feel that roads are not having a big effect on stream sedimentation and that most sediment is the result of stream bank erosion (McNeil, pers. comm. 2002). Soils within the forested portions of the watershed are generally permeable and overland flow is rare.

3.1.3.2.2 Mass Wasting

Mass wasting events can contribute large volumes of sediment to stream channels. No systematic assessment of mass wasting failures is available for the Canyon Creek watershed; however, based on available anecdotal information summarized below, it does not appear that mass wasting is a large source of sedimentation.

Grant County was included in a statewide inventory of mass failures associated with four large storms that occurred in 1996 and 1997 (Hofmeister 2000). Although these storm events were large (i.e., recurrence intervals up to or exceeding 25 years) in western Oregon, they do not appear to have been noteworthy in the area of the Canyon Creek watershed. Only one event in Grant County is identified in this inventory and it is located west of the Canyon Creek watershed along the South Fork of the John Day River.

Vegetation typing has recently been conducted in the watershed (see the *Current Vegetation* section for more details) using the Malheur, Umatilla, and Wallowa-Whitman National Forests Vegetation Polygon Mapping and Classification Standards. One of the "Existing Life Form" codes used in this typing is the "NL - Landform failure" code used to denote areas of natural slumps and other existing mass wasting features. Only one mass wasting feature was identified during this inventory; it is an area of approximately 11 acres that delivers to the fish-bearing tributary 4 of the Middle Fork Canyon Creek (Figure 3.6). This landslide has apparently existed since at least the fall of 1986, when it was first noted by a hunter in the area (Brown, pers. comm. 2002). The slide exists in an area that is primarily composed of volcanic ash type soils. This slide was not noted during a stream survey in the area conducted in 1994; however, an additional slide was noted along the Middle Fork Canyon Creek downstream of tributary 6 (Figure 3.6). This second slide was reported to have been approximately 160 feet long and approximately 20 to 30 feet high and was thought to have occurred in 1985/1986. The stream survey also reported an additional slide approximately 50 feet in length located immediately upstream of tributary 6. All three slides presumably occurred around the same time and all are located within the Strawberry Mountain Wilderness area.

3.1.4 Water Quantity

3.1.4.1 Effects of water withdrawals

The Oregon Water Resources Department (OWRD) Water Availability Report System (WARS) provides estimates of the net effects of water withdrawals on monthly stream flows at four locations within the Canyon Creek watershed (OWRD 2002c). The four locations are 1) the mouth of Canyon Creek, 2) East Fork Canyon Creek at the mouth, 3) Canyon Creek above East Fork Canyon Creek, and 4) Middle Fork Canyon Creek at the mouth.

In estimating the net effects of water withdrawals on monthly stream flows, the OWRD has taken into account the fact that a portion of the water withdrawn from the water source returns to the stream. Only the portion of each withdrawal that is actually consumed (i.e., the consumptive use) is included in the net estimate. A consumptive use is defined by the OWRD as any water use that causes a net reduction in stream flow (OWRD 2002c). These uses are usually associated with an evaporative or transpirative loss. The OWRD recognizes four major categories of consumptive use: irrigation, municipal, storage, and all others (e.g., domestic, livestock).

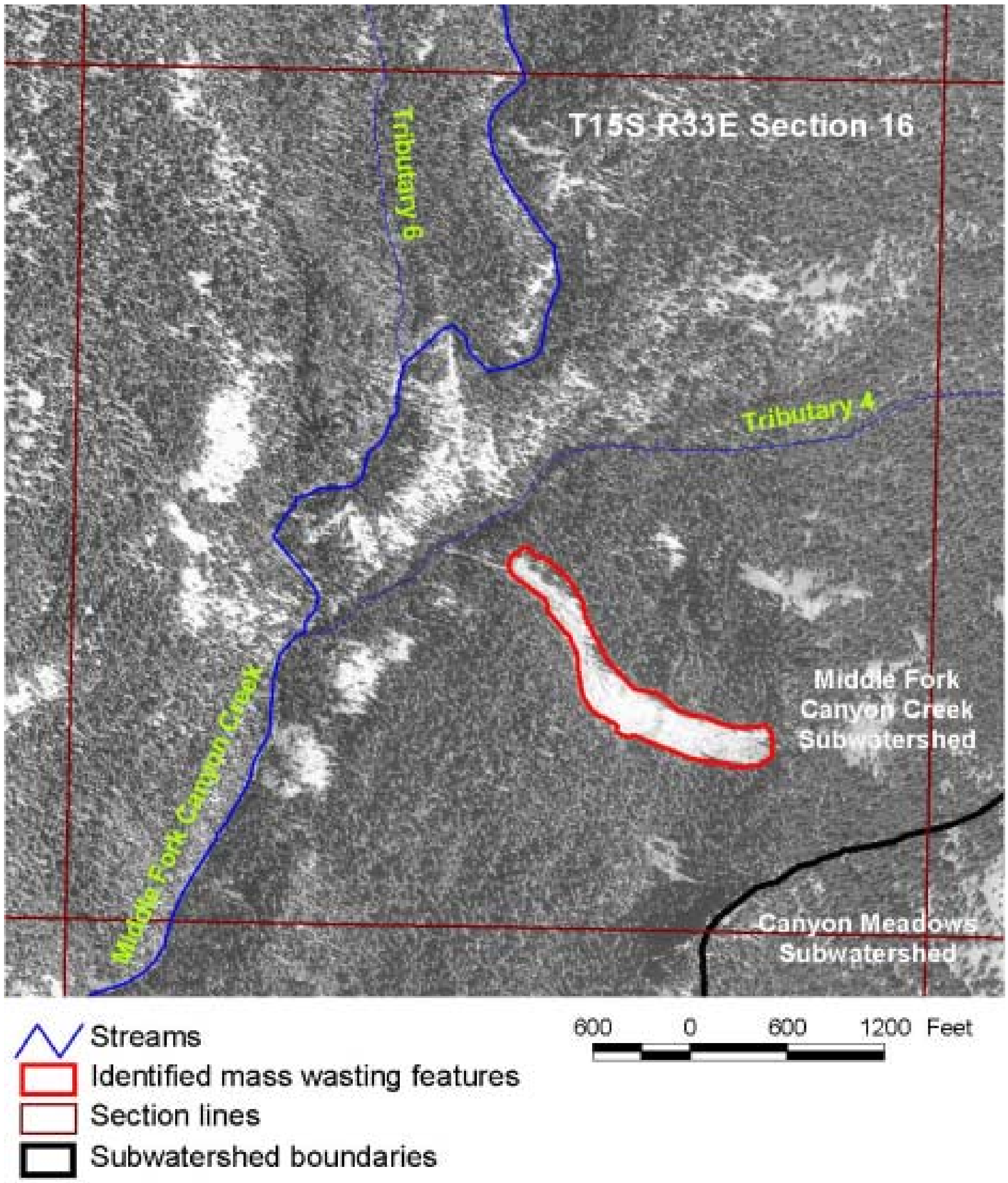


Figure 3.6. Location of mass wasting feature identified in the Middle Fork Canyon Creek subwatershed.

The OWRD estimates the consumptive use for irrigation using estimates made by the USGS, including estimates from the 1987 Census of Agriculture, estimates from the OSU Cooperative Extension Office, 1989-90 Oregon Agriculture and Fisheries Statistics, and an OSU Study of Crop Water Requirements (OWRD 2001b). Irrigation uses are not estimated to be 100% consumptive. Consumptive use from other categories of use is obtained by multiplying a consumptive use coefficient (e.g., for domestic use, the coefficient is 0.20) by the maximum diversion rate allowed for the water right. The OWRD assumes that all of the non-consumed part of a diversion is returned to the stream from which it was diverted. The exception is when diversions are from one watershed to another, in which case the use is considered to be 100% (i.e., the consumptive use equals the diversion rate).

The net effect of water withdrawals on monthly stream flows was estimated at each of the four locations (i.e., the mouths of Canyon, East Fork Canyon, and Middle Fork Canyon; and Canyon Creek above East Fork Canyon) in the following manner:

1. The estimated monthly natural stream flows[9] for average and dry years (represented by the 50% and 80% exceedance flow[10] respectively) were first plotted for each location.
2. The portion of all water withdrawals that does not return to the stream (i.e., the consumptive uses) was added to water diverted for storage for each month and plotted on the same graph.
3. If an instream water right exists for the subwatershed, this was also shown on the graph
4. Finally, the sum of instream water rights, consumptive uses, and storage was plotted on the graph.

Figure 3.7 (top graph) shows the estimated net effect of water withdrawals on monthly stream flows at the mouth of Canyon Creek. These estimates indicate that consumptive water use plus storage does not exceed the estimated volume of natural stream flow in any month in average years (50% exceedance flows); however, in dry years (80% exceedance flows) consumptive water use plus storage does exceed the estimated volume of natural stream flow in the months of August and September. In other words, if all the water that is allowed under existing water rights (exclusive of instream rights) is withdrawn, there would be stream flow in all months during "normal" years, but there would be no stream flow in the months of August and September in "dry" years. Instream

[9] *As calculated by the OWRD.*

[10] *The 50% exceedance stream flow is the stream flow that occurs at least 50% of the time in a given month. Conversely, the stream flow is also less than the 50% exceedance flow half the time. The 50% exceedance flow can be thought of as the average stream flow for that month. The 80% exceedance stream flow is exceeded 80% of the time. The 80% flow is smaller than the 50% flow and can be thought of as the stream flow that occurs in a dry month. These exceedance stream flow statistics are used by the OWRD to set the standard for over-appropriation: the 50% exceedance flow for storage and the 80% exceedance flow for other appropriations (OWRD, 2002c).*

water rights are limited to no more than the natural 50% exceedance stream flow (OWRD 2002a). It appears, based on the data shown in Figure 3.7 (top graph), that the instream water rights for Canyon Creek at the mouth were set at or near the natural 50% exceedance stream flow for the summer and fall months. Consequently, the sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow in both average (50% exceedance flows) and dry (80% exceedance flows) years in the months of October to February and July to September. In other words, there is no way, given these estimated volumes of natural flow and the water withdrawals allowed, for the instream water rights to be fulfilled in these months.

Figure 3.7 (bottom graph) shows the estimated net effect of water withdrawals on monthly stream flows at the mouth of East Fork Canyon Creek. These estimates indicate that consumptive water use plus storage does not exceed the estimated volume of natural stream flow in any month in either average (50% exceedance flows) and dry (80% exceedance flows) years. In other words, if all of the water is withdrawn that is allowed under existing water rights (exclusive of instream rights), there would still be some stream flow in all months during both “normal” and “dry” years. The sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow during average years (50% exceedance flows) in the months of July, August, September, and October. In dry years (80% exceedance flows), the sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow during all months except April and May. In other words, instream water rights will not be fulfilled in these months if all other water rights are fully used.

The estimated net effect of water withdrawals on monthly stream flows for Canyon Creek above the mouth of East Fork Canyon Creek is show in Figure 3.8 (top graph). These estimates indicate that consumptive water use plus storage does not exceed the estimated volume of natural stream flow in any month in either average (50% exceedance flows) or dry (80% exceedance flows) years. In other words, if all the water is withdrawn that is allowed under existing water rights (exclusive of instream rights), there would still be some stream flow in all months during both “normal” and “dry” years. The sum of instream water rights, consumptive uses, and storage does not exceed the estimated volume of natural stream flow during average years (50% exceedance flows) in any month. In dry years (80% exceedance flows), the sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow during all months except April, May, and June. In other words, instream water rights will not be fulfilled in these months if all other water rights are fully used.

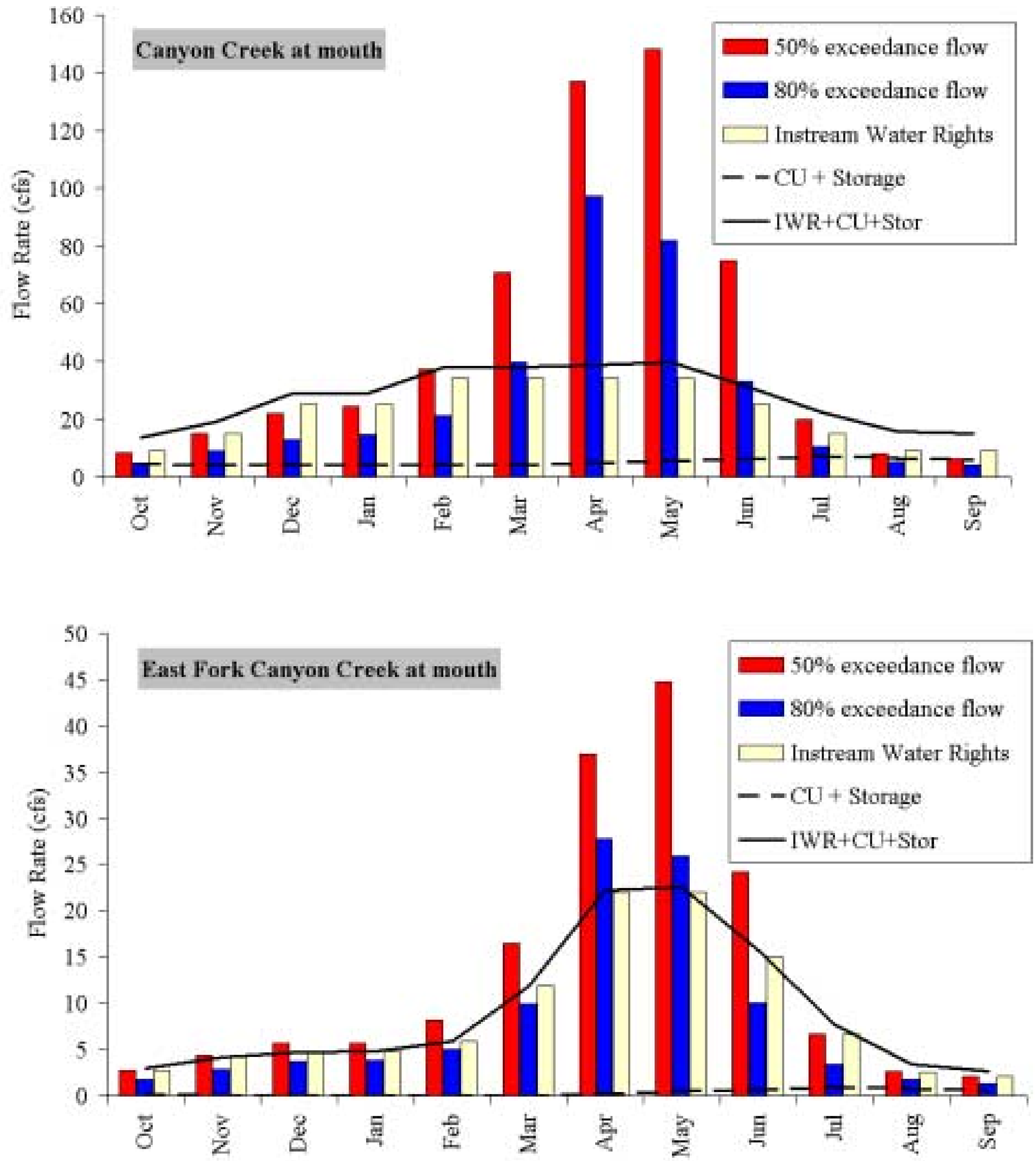


Figure 3.7. Estimated net effect of water withdrawals on monthly stream flows at the mouth of Canyon Creek (top graph) and at the mouth of the East Fork Canyon Creek (bottom graph).

Shown in Figure 3.7 are estimated natural stream flows for average and dry years (50% and 80% exceedance flows); instream water rights; the sum of consumptive uses (CU) and water storage; and the sum of instream water rights (IWR), consumptive uses (CU) and storage (STOR) (data source: OWRD [2002a]).

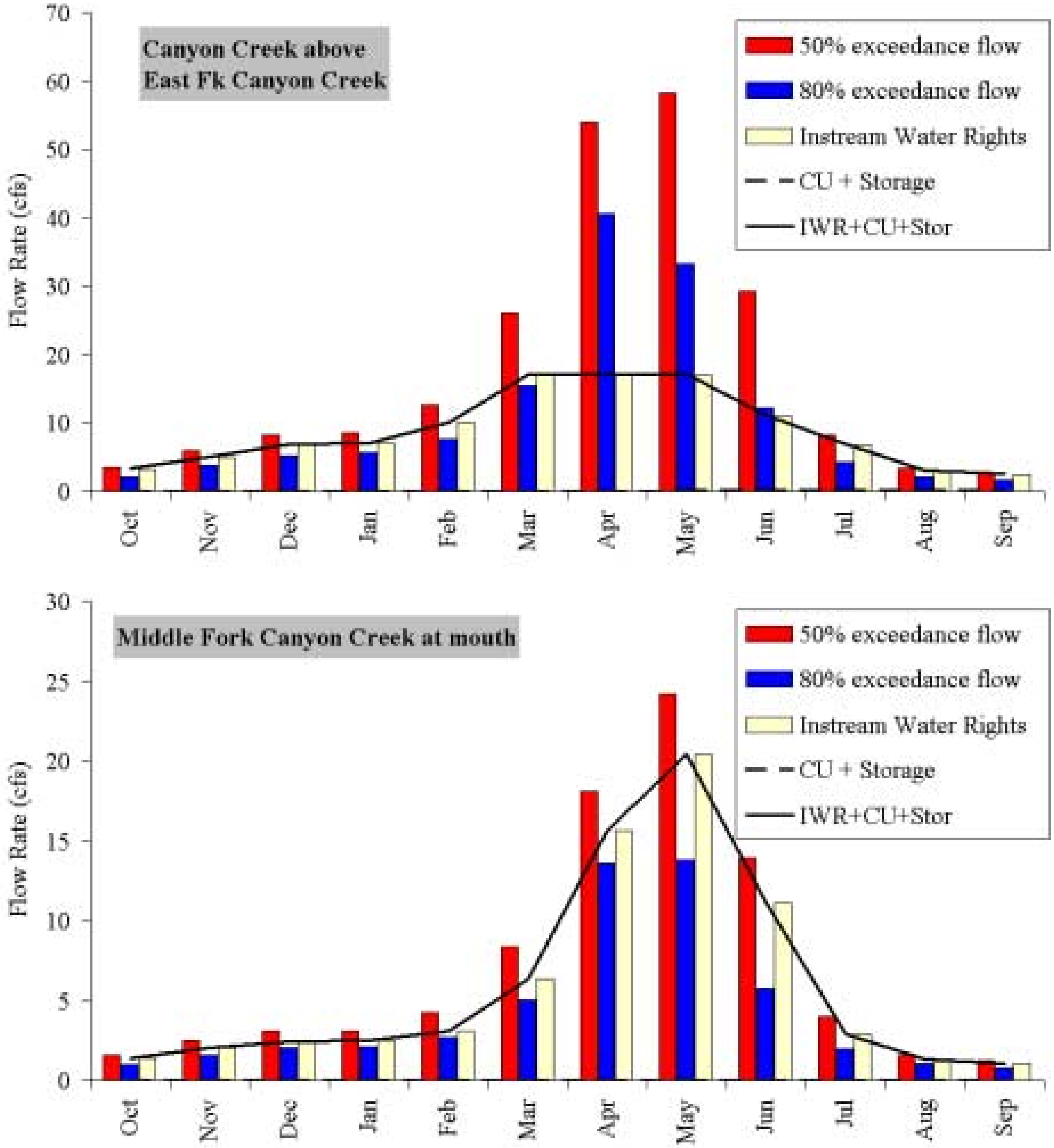


Figure 3.8. Estimated net effect of water withdrawals on monthly stream flows at Canyon Creek above East Fork Canyon (top graph), and at the mouth of the Middle Fork Canyon Creek (bottom graph).

Shown in Figure 3.8 are estimated natural stream flows for average and dry years (50% and 80% exceedance flows); instream water rights; the sum of consumptive uses (CU) and water storage; and the sum of instream water rights (IWR), consumptive uses (CU) and storage (STOR) (data source: OWRD [2002a]).

Figure 3.8 (bottom graph) shows the estimated net effect of water withdrawals on monthly stream flows for the Middle Fork of Canyon Creek at the mouth. These estimates indicate that consumptive water use plus storage does not exceed the estimated volume of natural stream flow in any month in either average (50% exceedance flows) or dry (80% exceedance flows) years. In other words, if all of the water is withdrawn that is allowed under existing water rights (exclusive of instream rights), there would still be some stream flow in all months during both "normal" and "dry" years. When instream rights are added, the sum of instream water rights, consumptive uses, and storage does not exceed the estimated volume of natural stream flow during average years (50% exceedance flows) in any month. In dry years (80% exceedance flows), the sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow during all months. In other words, instream water rights will not be fulfilled in these months if all other water rights are fully utilized.

3.1.4.2 Effects of Other Land Uses

Figure 3.9 is a generalized diagram showing the primary interactions between land use impacts that may be found in the Canyon Creek watershed and changes in peak, annual, and low stream flows. Note that Figure 3.9 does not include "top-level" land uses (e.g., Urbanization, Agriculture, Forest Management, etc.). The reason for this is that there often is considerable overlap between top-level land uses and the underlying hydrologic processes that they affect. For example, both forest management and agricultural practices have the ability to affect vegetation removal, soil erosion/mass wasting, wetland degradation, channel down-cutting, dike/levee construction, soil compaction, and road development. This analyst believes that, rather than discussing impacts by top-level land uses, it is more appropriate to discuss land use impacts in terms of the underlying processes.

Vegetation Removal. Rain-on-snow (ROS) is the common term used to describe wintertime conditions when relatively warm wind and rain combine to produce rapid snowmelt (Coffin and Harr 1992). ROS flood events may occur in areas having appreciable wintertime snow packs and are independent of land use. Removal of the forest canopy can augment ROS peak flows by increasing snow accumulation in openings (Troendle 1983, Bosch and Hewlett 1982) and increasing the rate of snowmelt by increasing the effective wind speeds at the snowpack surface (Harr 1981, Harr 1986, Coffin and Harr 1992). The extent to which forest removal may augment ROS peak flows is a function of the amount of harvesting within the elevation range that defines the ROS zone. At low elevations (below the ROS zone), winter temperatures are generally too warm to allow for much snow accumulation, and at higher elevations wintertime precipitation generally falls as snow. As discussed in *Chapter 1* of this report, ROS appears to be an important process in peak flow generation within the Canyon Creek watershed. Consequently, the potential exists for peak flows to be augmented by forest harvesting.

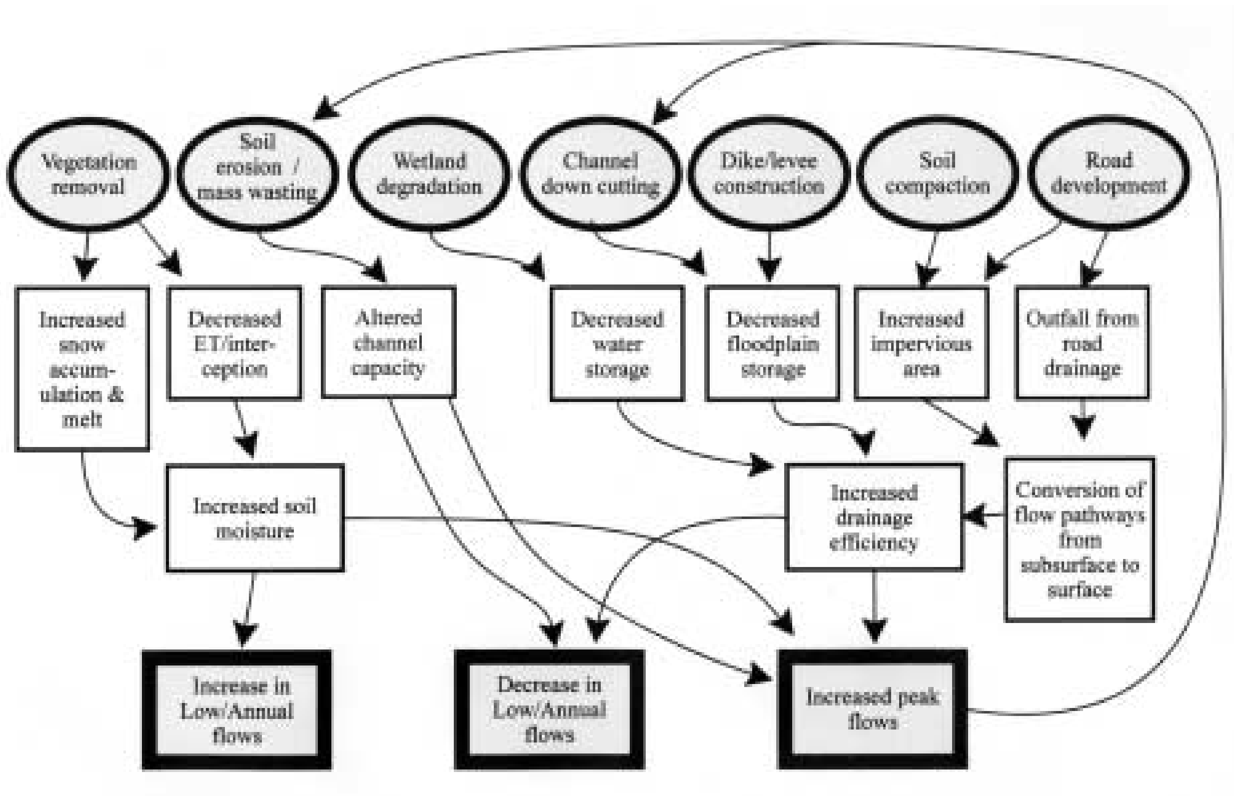


Figure 3.9. Generalized diagram of the primary interactions between land uses and changes in peak, annual, and low stream flows (adapted from Ziemer, 1998).

Similarly, in a model simulation of a snowmelt-dominated watershed in interior British Columbia, Whitaker et al. (2002) found that greater snow accumulation and melt in clear-cut areas also result in peak flow increases. The authors found that vegetation removal in the bottom 20% of a drainage results in little or no change in peak flow due to the thin low-elevation snowpack and the timing of snowmelt, while clear-cut area correlates well with peak flow increases at higher elevations.

Vegetation can intercept a portion of the precipitation falling on a watershed, a further portion of which is evaporated back to the atmosphere during or after a storm event, thereby reducing the net precipitation reaching the soil (Dunne and Leopold 1978). Evapotranspiration by vegetation removes moisture from the soil profile and returns it to the atmosphere (Dunne and Leopold, 1978). Increases in peak flows have been observed in some situations following harvest of trees, which are presumed to be the result of loss of canopy interception and evapotranspiration (Ziemer 1998). Several studies (Harr et al. 1979, Helvey 1980, Harr and Krygier 1972, Bosch and Hewlett 1982, Harr 1983, Hetherington 1987, Kattelmann et al. 1983, Troendle 1983, and Keppeler 1998) have shown that water yield increases throughout the year, with the largest relative increases occurring during the summer and early fall months following logging. These studies have reported increases in summer flows ranging from 15% to 148%.

Both increased snow accumulation and melt and decreased evapotranspiration and canopy interception can increase levels of soil moisture, resulting in increased peak flows, low flows, and annual stream flow volumes. Conversely, the expansion of western juniper communities may have the effect of reducing water yields and lowering base flows.

Western juniper is a native species to eastern Oregon. Juniper forests, defined as areas having at least 10% juniper crown cover, occur on more than 2.2 million acres in eastern Oregon today (Gedney et al. 1999). This is a five-fold increase from an earlier inventory conducted in 1936 that estimated the area of juniper forest to be 420,000 acres (Cowlin et al. 1942). The majority of the present juniper forests was established between 1850 and 1900 during a period of reduced fire frequency and intensity and drought-free climatic conditions (Gedney et al. 1999). Juniper expansion during this period may also be linked to the introduction of large numbers of livestock which led to a loss of fine fuels from grazing, further reducing the frequency of fire (Belsky 1996). Future expansion of juniper forests is predicted to occur in areas now classified as juniper savanna, as crown cover of juniper trees increases from less than to more than 10%, potentially increasing the area of juniper forest in the state to as much as five million acres (Gedney et al. 1999) (see *Juniper Encroachment s*ection of this chapter for further discussion of western juniper).

Juniper can have an effect on the amount of precipitation reaching the soil. Gedney et al. (1999) report that the crown of juniper trees intercept more than half the annual precipitation, which is returned to the atmosphere through evaporation or sublimation (the process whereby snow passes directly to water vapor without melting). Juniper can out-compete other vegetation for available soil moisture by transpiring year-round and through its extensive root networks that can occupy an area several times larger than the tree's crown diameter (Gedney et al. 1999).

Although the potential exists for juniper to reduce stream flows through canopy interception and removal of soil moisture, little quantitative research is available that proves this to be the case.

The majority of applicable water yield studies has been conducted in the southwestern United States on watersheds dominated by pinyon-juniper woodlands. Most of these studies found no increase in water yield following pinyon-juniper removal (Belsky 1996). A study conducted by Clary et al. (1974) found no change in water yield when trees were removed by cabling and then burned or were felled by hand and left in place, but did find increases in streamflow when trees were killed by herbicide and left standing. The increases in water yield found by Clary et al. (1974) may have been due to the absence of soil disturbance and continued shade from the standing dead trees in the herbicide-treated watershed. Several reasons explain why increases in water yield following removal of juniper may not be realized (the following is taken from Belsky 1996):

- In arid and semi-arid climates, most snow- and rain-water simply recharge the soil column; little excess is available to move downslope to streams.
- Herbaceous plants and shrubs that replace trees also intercept rain and snow, reducing the amount of water reaching the ground.
- Replacement plants also transpire and deplete soil water.
- Tree removal exposes the soil and understory plants to direct sunlight, causing elevated temperatures and increased evapotranspiration.
- Tree removal exposes soils and understory plants to more wind, which increases evapotranspiration.
- In areas where water is in excess of that needed to recharge the soil, this water may go to shallow aquifers rather than to streams.

No quantitative information is available for the Canyon Creek watershed on possible impacts to streamflow due to changes in vegetation composition.

Soil erosion and mass wasting. Soil erosion and mass wasting can increase quantities of sediments transported in stream systems. Deposition of both coarse and fine sediments in stream channels can result in a decrease in channel conveyance capacity, leading to an effective increase in frequency of flooding (Dunne and Leopold 1978). In addition to the effects on peak flows, increases in aggradation of coarse sediments can increase the proportion of streamflow that travels subsurface, resulting in a reduction of effective summer low flows. Furthermore, increased peak flows can further exacerbate sedimentation problems through increased bank erosion and mass wasting. No quantitative information on channel aggradation or sedimentation is available for the Canyon Creek watershed.

Wetland degradation. Wetlands have the ability to intercept and store storm runoff, thereby reducing peak flows (Mitsch and Gosselink 1986). This water is released over time and may be important to augment summertime low flows. No quantitative information on wetland loss is available for the Canyon Creek watershed. However, it is likely that most streams in the watershed have experienced some level of stream incision and down-cutting, which is likely to have resulted in wetland loss (McNeil, pers. comm. 2002).

Channel down-cutting and channelization. Channel down-cutting and channelization have the same effect on the stream system: decreasing the amount of water that can be stored in channel banks and the floodplain. The difference between the two processes are that channel down-cutting occurs without direct human assistance in response to changes in water volume and sediment loads, whereas channelization occurs through conscious human design through the construction of dikes and levees. Potential disadvantages to dikes and levees include loss of floodwater storage within the floodplain, which can result in higher downstream peak flows, reduced groundwater recharge, and subsequently lower summertime base flows.

No quantitative information on channel down-cutting is available for the Canyon Creek watershed. However, as stated above, it is likely that most streams in the watershed have experienced some level of stream incision and down-cutting (McNeil, pers. comm. 2002), which is likely to have resulted in loss of bank storage. In addition, a decrease in the beaver population, and the subsequent loss of beaver dams within the watershed, may be a contributing factor to loss of water storage and channel down cutting.

Soil compaction. Soil compaction can increase the amount of impervious area occurring in a watershed. Increases in the amount of impervious area result in increased peak flow magnitudes. By eliminating or reducing infiltration of precipitation, the travel time to stream channels is shortened (Dunne and Leopold 1978). In addition to the effects on peak flows, increases in impervious area also reduce summer low flows by reduction of groundwater recharge (Dunne and Leopold 1978). May et al. (1997) suggest that impairment begins when percent total impervious area in a watershed reaches 10%.

One approach to assessing the potential impacts of compaction at the subwatershed scale is through use of the equivalent roaded area (ERA) analysis (McGurk and Fong 1995). The ERA methodology is a cumulative effects assessment tool that converts timber harvest, fires, and grazing effects into the equivalent area of roads that these activities would represent. This is done through the use of coefficients that are applied to the area occupied by each activity. The result from the ERA analysis is the proportion of the analysis area (expressed as a percentage) that is "equivalent" to a similar area occupied by roads. The results of the analysis are compared with a threshold of concern (TOC) that is specific to each area. An ERA analysis has been completed for the Middle Fork Canyon Creek, Canyon Meadows, and Vance Creek subwatersheds (McNeil, pers. comm. 2002), the results are given in Table 3.32.

Table 3.32. Equivalent roaded area (ERA) calculations for three subwatersheds withinthe Canyon Creek watershed.

			Equivalent roaded area (acres)						
Subwatershed	***Area (acres)***	***Year***	***Roads***	***Timber harvest***	***Fire***	***Grazing***	***Total***	***ERA (%)***	***TOC (%)***
Middle Fork Canyon Creek	7,079	1,998	66	331	97	27	521	**7.4%**	**12%**
		2,003	66	257	82	27	432	**6.1%**	
Canyon Meadows	8,662	1,998	167	279	8	45	499	**5.8%**	**14%**
		2,003	167	215	7	45	434	**5.0%**	
Vance Creek	4,758	1,994	101	526	8	53	688	**14.5%**	**12%**
		2,003	101	341	5	53	500	**10.5%**	

Also shown are threshold of concern (TOC) values for each subwatershed (Source: R. McNeil, pers. comm. 2002).

The results for the ERA model runs suggest that compaction is currently below the threshold of concern for all three of the subwatersheds that were analyzed, although current conditions are close to the threshold within the Vance Creek subwatershed.

No additional quantitative information is available on soil compaction for the remainder of the Canyon Creek watershed. However, analyses associated with timber sale preparation suggests that only a very small portion (<5%) of most forested area are detrimentally impacted (McNeil, pers. comm. 2002). Most compaction in forested areas is most likely legacy conditions from past ground-based logging activities in the 1950s.

Outfall from road drainage. Road networks have the potential to affect watershed hydrology by changing the pathways by which water moves through the watershed. Road networks affect flow routing by interception of subsurface flow at the road cutslope (Megahan 1972, Burroughs et al. 1972, King and Tennyson 1984, Best et al. 1995) and through a reduction in road-surface infiltration rates resulting in overland flow (Ziemer 1998). The net result may be that surface runoff is routed more quickly to the stream system if the road drainage network is well-connected with the stream channel network.

No information is available for the Canyon Creek watershed on the level of connectivity between the road drainage and stream channel networks. Further study of this possible impact should be focused on those subwatersheds that have the highest road densities (see Table 3.28).

3.1.5 Physical Stream Channel Characteristics

3.1.5.1 Channel Types

Classification of stream channels within a watershed is an important part of understanding the inherent spatial variation in aquatic habitat conditions and is important in prioritizing and understanding the limitations to possible restoration activities. The underlying assumption in any channel typing scheme is that the morphological channel characteristics are the result of geologic, climatic, and vegetative interactions. Furthermore, similar channel types can be expected to respond in a similar manner to natural or human-caused changes within a watershed in the supply of water, sediment, or wood inputs.

The classification scheme used in this analysis is commonly referred to as the Rosgen methodology (Rosgen 1994). The Rosgen methodology utilizes a hierarchical approach to channel classification. The most extensive classification within the methodology, the Level I classification, is based on broad-scale features that can be remotely derived.

A description of the Rosgen level I classification is provided in Table 3.33.

Table 3.33. Characteristics of Rosgen stream type classifications.

Stream type	General description	Entrench-ment ratio	W/D ratio	Sinuosity	Slope	Landform/soils/features
Aa +	Very steep, deeply entrenched, debris transport streams.	< 1.4	< 12	1.0 to 1.1	>0.10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with/deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	< 1.4	< 12	1.0 to 1.2	0.04 to 0.10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step-pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4 to 2.2	> 12	> 1.2	0.02 to 0.039	Moderate relief, colluvial deposition and/or residual soils. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate with occasional pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains	> 2.2	> 12	> 1.4	< 0.02	Broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channel. Riffle-pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	> 40	n/a	< 0.04	Broad valleys with alluvial and colluvial fans. Glacial debris and depositional features. Active lateral adjustment, with abundance of sediment supply.
DA	Anastomosing (multiple channels) narrow and deep with expansive well vegetated floodplain and associated wetlands. Very gentle relief with highly variable sinuosities. Stable streambanks.	> 4.0	< 40	Variable	< 0.005	Broad, low-gradient valleys with fine alluvium and/ or lacustrine soils. Anastomosed (multiple channel) geologic control creating fine deposition with well-vegetated bars that are laterally stable with broad wetland floodplains.
E	Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratio.	> 2.2	< 12	> 1.5	< 0.02	Broad valley/meadows. Alluvial materials with floodplain. Highly sinuous with stable, well vegetated banks. Riffle-pool morphology with very low width/depth ratio.
F	Entrenched meandering rime/pool channel on low gradients with high width/depth ratio.	< 1.4	> 12	> 1.4	< 0.02	Entrenched in highly weathered material. Gentle gradients, with a high W/D ratio. Meandering, laterally unstable with high bank-erosion rates. Riffle-pool morphology.
G	Entrenched "gulley" step/pool and low Width/depth ratio on moderate Gradients.	< 1.4	< 12	> 1.2	0.02 to 0.039	Gulley, step-pool morphology with moderate slopes and low W/D ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials; i.e., fans or deltas. Unstable, with grade control problems and high bank erosion rates.

From Rosgen (1994).

The Rosgen level I approach is based primarily on four factors: the stream entrenchment ratio, which is the ratio of the flood prone area to the bankfull channel width; the bankfull channel width to bankfull depth ratio; channel sinuosity; and channel gradient or slope. All these parameter, with the exception of the width-depth (w-d) ratio, can be remotely derived.

The Rosgen level I classification methodology was applied to Class 1-3 streams within the Canyon Creek watershed. The spatial distribution of Rosgen channel types are shown in Map 3.9 and summarized in Figure 3.10.

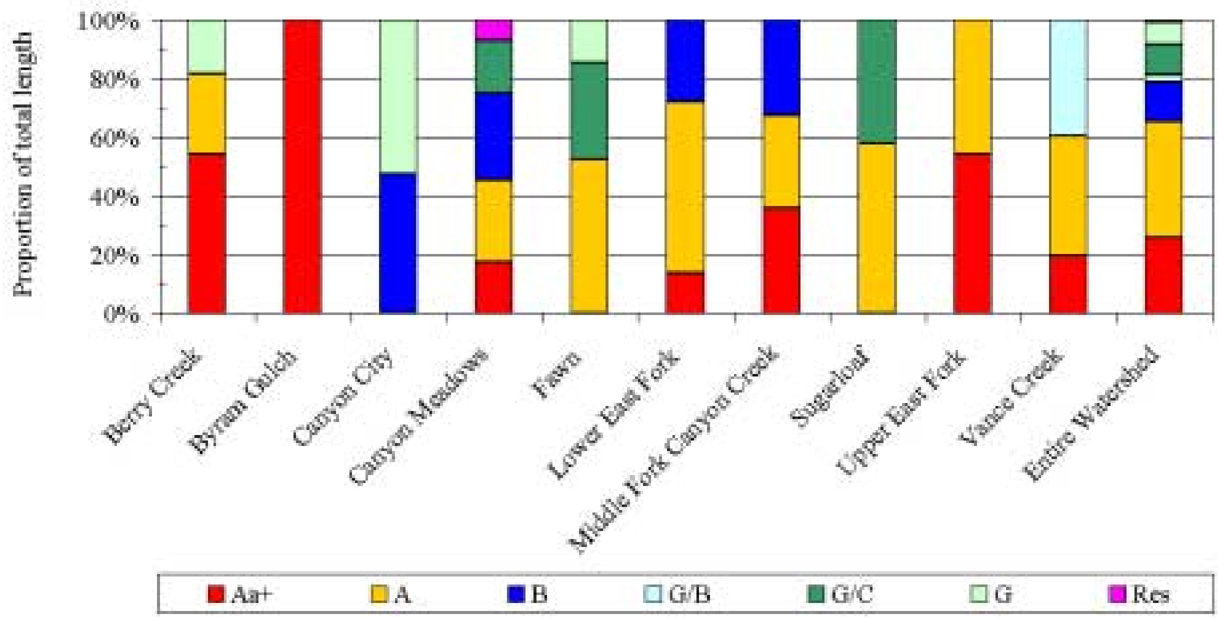


Figure 3.10. Distribution of Rosgen level I channel types by subwatershed, and for the entire Canyon Creek watershed.

The “Aa+” stream types are very steep (>10% channel gradient) streams located exclusively in headwater areas in the Canyon Creek watershed (Map 3.9). Transport processes dominate in these reaches, as they are often source areas for downstream deposition. Type Aa+ channels make up approximately one-quarter of the stream length within the entire Canyon Creek watershed and range from 100% of the total channel length in the Byram Gulch subwatershed to 14% in the Lower East fork subwatershed (Figure 3.10). Type Aa+ channels are not found at all in the Canyon City, Fawn, or Sugarloaf subwatersheds.

Channel type “A” are similar to the “Aa+” classification, the primary difference being that these channel types are lower gradient (4-10%). Consequently, these channel types tend to be located immediately downstream of the type “Aa+” channels (Map 3.9). Type A channels make up the largest proportion (40%) of the stream length within the entire

Canyon Creek watershed, and are found in all subwatersheds with the exception of Byram Gulch and Canyon City, ranging from 58% of the total channel length in the Lower East Fork and Sugarloaf subwatersheds to 27% in the Berry Creek subwatershed (Figure 3.10).

Rosgen channel type “B” streams typically are positioned downstream of type “A” channels (Map 3.9) because they are more moderate in gradient. Although these streams are morphologically dominated by hillslope (as opposed to floodplain) processes, they often contain some areas of floodplain development and may be both transport and depositional reaches. Within the Canyon Creek watershed, type “B” channels are typically found at the lower end of the larger tributaries (Map 3.9); one exception is the section of type “B” channel located along the mainstem of Canyon Creek downstream of Byram Gulch. Type “B” channels make up 13% of the stream length in the entire Canyon Creek watershed and are found within five of the nine subwatersheds where they comprise from 28% to 47% of the total channel length (Figure 3.10).

Rosgen type “G” or “gullied” channels are narrow, entrenched, non-meandering channels that are often downcut within alluvial deposits. The majority of the mainstem of Canyon Creek downstream of Vance Creek has been classified as a “G” type channel (Map 3.9). In addition, several streams within the watershed exhibit some “G” channel type characteristics, although it was not clear (based on available information) if these channels are truly “G” types. The downstream portion of Vance Creek (Map 3.9) exhibits characteristics of both “B” and “G” channel types: consequently, this area was classified as a “G/B” type. Similarly, the mainstem of Canyon Creek upstream of Vance Creek exhibits characteristics of both the “G” and “C” channel types and was classified as a “G/C” channel type. Rosgen type “C” channels consist of relatively low-gradient streams with well-developed floodplains and are typically highly responsive to sediment and wood inputs.

The final channel type shown in Map 3.9 is the “RES” channel type. This is not a Rosgen type, but rather refers to the portion of Canyon Creek that flows through the site of the Canyon Meadows reservoir.

3.1.5.2 Stream Channel Characteristics

Very few data are readily-available to characterize current stream channel conditions within the Canyon Creek watershed. The primary source of data, and the only source used in the analysis presented here, is the Stream Management, Analysis, Reporting, and Tracking (SMART) database, that consists of several stream surveys conducted within the watershed during summer 1993 and 1994. Additional fishery habitat surveys conducted during 1982 to 1986 contain general information on riparian plant communities, pool/riffle counts, stream stability, etc.; however, these data exist only on field forms that have not been summarized. Consequently, these data were not included in this analysis.

The SMART data were useful in evaluating fish habitat at the reach and subwatershed scales. Characteristics such as pieces of LWD and number of pools per mile of stream are useful in evaluating the longitudinal connectivity of instream habitats available for fish. These data, in combination with streambed substrate, stream gradient, stream temperature, shade, and LWD potential are useful indicators in evaluating how habitat is functioning for salmonids (NOAA Fisheries 1996, USFWS 1996). A synthesis of the physical habitat characteristics information presented in this chapter will be presented in the S*ynthesis and Interpretation* section in *Chapter 5-6*.

The SMART reaches are located primarily within the Middle Fork Canyon Creek, Canyon Meadows, and Vance Creek subwatersheds (Table 3.34, Map 3.2). All reaches included in the SMART surveys are located on National Forest lands. data is summarized for the 23 individual reaches in Table 3.34, Table 3.35, and Table 3.36. A total of 30 miles of stream was included in the SMART database (Table 3.35). The majority of the stream reaches were classified as having either narrow or moderate V-shaped valleys shape, with valley floor widths less than 100 feet and steep valley side slopes. Only the lower portions of the Middle Fork Canyon Creek and Canyon Creek proper reaches were classified as having flat valley floors. Only the Middle Fork Canyon Creek tributaries T4, T6, and T7 were rated as “deeply” incised; the remaining reaches being evenly split between “moderate” and “shallow” entrenchment.

Average wetted and bankfull widths and average residual pool depths are given in Table 3.35. Residual pool depth is defined as the depth below the lowest point of the pool tailout. Bankfull w-d ratios range from 5.8 in Vance Creek Reach #3, to 17.6 in Middle Fork Canyon Creek Reach #2. Wetted w-d ratios range from 5.5 in Middle Fork Canyon Creek T6 to 15.1 in Canyon Creek Reach #2. The Northwest Forest Plan defines streams as “Functioning appropriately” when the wetted w-d ratio is <10; “Functioning at risk” when the w-d ratio is 11 to 20, and “Functioning at Unacceptable risk” when the w-d ratio is >20. Based on this criteria, thirteen of the 23 reaches would be classified as “Functioning appropriately,” and the remaining streams would be “Functioning at risk.”

Stream channel bed and bank conditions are summarized for the SMART reaches in Table 3.36. The dominant streambed substrate among the reaches is cobble-sized material in ten of the reaches, gravel in eight reaches, sand in four reaches, and small boulders in one reach. Coarseness of streambed material generally increases with increasing channel gradient. Sub-dominant streambed material is primarily gravel in the cobble-dominated reaches and sand in the gravel-dominated reaches. The majority of stream banks are reported as being 76-100% armored, with the remainder being 51-75% armored. The dominant bank substrate is primarily gravel and sand, with some areas of cobble and one reach being bedrock-dominated. Sub-dominant bank substrate is also primarily gravel and sand. The majority (12) of the reaches are identified as not being embedded (i.e., the estimated cobble embeddedness is <35%).

Table 3.34. SMART database – general reach characteristics.

Reach	Nominal river mile: From	Nominal river mile: To	Surveyed length (miles)	(1) Valley form	Sinuosity	(2) Channel entrenchment	(3) Width Class	Gradient (%)
Vance: Reach #1	0.3	1.0	0.9	2	1.06	M	1	3
Vance: Reach #2	1.0	2.2	1.2	2	1.04	S	1	4
Vance: Reach #3	2.2	3.0	0.9	2	1.16	S	1	8
MF Canyon: Reach #1	0.0	2.6	2.8	8	1.06	M	2	2
MF Canyon: Reach #2	2.6	3.9	1.5	8	1.02	S	2	4
MF Canyon: Reach #3	3.9	5.0	1.2	3	1.1	S	1	5
MF Canyon: Reach #4	5.0	6.2	1.0	3	1.07	M	1	4
MF Canyon: Reach #5	6.2	6.6	0.4	3	1.12	M	1	7
SF Vance: Reach #1	0.0	1.2	1.4	2	1.03	S	1	11
Fawn: Reach #1	0.3	1.2	0.9	3	1.12	M	1	8
Canyon: Reach #1	17.0	17.9	1.1	8	1.02	S	2	2
Canyon: Reach #2	17.9	19.9	2.5	8	1.04	S	2	2
Canyon: Reach #3	19.9	22.2	2.5	8	1.07	M	2	4
Canyon: Reach #4	22.2	23.0		8	1	S	2	0
Canyon: Reach #5	23.0	24.0	1.1	3	1.04	S	1	3
Crazy 94: Reach #1	0.0	2.1	2.6	3	1.05	S	1	6
MF Canyon T1: Reach #1	0.0	0.5	0.5	3	1	M	1	25
Canyon Wild: Reach #1	24.0	24.6	0.8	3	1	M	1	5
Canyon Wild: Reach #2	24.6	26.3	1.9	3	1.13	M	1	9
MF Canyon T6: Reach #1	0.0	0.7	0.8	3	1.17	D	1	15
MF Canyon Wild: Reach #1	6.6	8.2	1.8	3	1.19	M	1	9
MF Canyon T4: Reach #1	0.0	1.7	1.9	2	1.13	D	1	16
MF Canyon T7: Reach #1	0.0	0.3	0.3	3	1.2	D	1	13

Note: (1) Valley form classes: 2: Narrow V-shaped, floor width <100ft with >60% side slope
3: Moderate V-shaped, floor width <100ft with 30-60% side slope
8: Narrow flat-floored, floor width 100-300ft with >30% sideslope
(2) Channel entrenchment: D= deep; M=moderate; S=shallow
(3) Width classes: 1=valley width <100ft; 2=valley width 100-300ft

Table 3.35. SMART database – Channel widths and depths.

Reach	Average wetted width (ft)	Average bankfull width (ft)	Average residual depth (ft)	Bankfull width-depth ratio	Wetted width-depth ratio
Vance: Reach #1	6.5	10.3	1.1	8.14	7.76
Vance: Reach #2	5.2	11.1	1.1	10.08	8.42
Vance: Reach #3	5.4	10.5	1.1	5.81	5.82
MF Canyon: Reach #1	12.4	26.6	1.6	15.26	9.60
MF Canyon: Reach #2	12.2	25.0	1.4	17.58	12.65
MF Canyon: Reach #3	11.3	19.3	1.5	12.18	10.60
MF Canyon: Reach #4	9.5	11.5	1.3	7.48	11.27
MF Canyon: Reach #5	7.7	10.0	1.5	8.33	7.68
SF Vance: Reach #1	3.5	15.0	0.7	16.33	7.19
Fawn: Reach #1	3.1	5.7	0.6	6.87	11.02
Canyon: Reach #1	12.8	16.6	1.6	11.19	12.51
Canyon: Reach #2	9.2	17.9	1.2	14.96	15.13
Canyon: Reach #3	7.8	13.3	1.1	10.99	10.89
Canyon: Reach #4					
Canyon: Reach #5	6.5	12.5	1.0	11.26	11.56
Crazy 94: Reach #1	3.3	4.0	0.6	8.76	8.43
MF Canyon T1: Reach #1	3.3	5.0	0.6	6.73	5.80
Canyon Wild: Reach #1	6.2	10.3	0.8	17.00	10.42
Canyon Wild: Reach #2	5.2	8.7	0.7	14.21	9.81
MF Canyon T6: Reach #1	3.2	4.2	0.7	7.36	5.54
MF Canyon Wild: Reach #1	5.3	8.9	0.9	12.42	7.28
MF Canyon T4: Reach #1	4.8	7.8	0.8	10.76	7.52
MF Canyon T7: Reach #1	3.8	5.5	0.6	10.55	6.59

Table 3.36. SMART database – channel bed and bank condition.

Reach	(1) Dominant channel bed substrate	Sub-dominant channel bed substrate	(2) Embedded-ness	(3) Bank ground cover	Dominant bank substrate	Sub-dominant bank substrate
Vance: Reach #1	GR	SA	Y	4	SA	GR
Vance: Reach #2	GR	SA	N	4	SA	GR
Vance: Reach #3	SA	GR	Y	4	SA	GR
MF Canyon: Reach #1	GR	CO	N	4	GR	SA
MF Canyon: Reach #2	CO	GR	N	4	GR	SA
MF Canyon: Reach #3	CO	SB	N	4	GR	SA
MF Canyon: Reach #4	CO	GR	N	4	GR	CO
MF Canyon: Reach #5	SB	CO	Y	4	BR	GR
SF Vance: Reach #1	SA	GR	Y	3	SA	SA
Fawn: Reach #1	SA	GR	Y	3	SA	GR
Canyon: Reach #1	GR	SA	N	3	GR	SA
Canyon: Reach #2	GR	CO	N	4	GR	SA
Canyon: Reach #3	CO	GR	Y	4	GR	SA
Canyon: Reach #4	SA	SA				
Canyon: Reach #5	GR	SA	Y	4	GR	SA
Crazy 94: Reach #1	GR	SA	Y	4	GR	CO
MF Canyon T1: Reach #1	CO	GR	N	4	SA	GR
Canyon Wild: Reach #1	CO	GR	Y	3	GR	GR
Canyon Wild: Reach #2	CO	GR	Y	4	CO	GR
MF Canyon T6: Reach #1	GR	SA	N	3	SA	GR
MF Canyon Wild: Reach #1	CO	GR	N	4	CO	GR
MF Canyon T4: Reach #1	CO	GR	N	4	CO	GR
MF Canyon T7: Reach #1	CO	GR	N	3	CO	GR

Notes: (1): Substrate codes: BR= Bedrock, CO= Cobble, GR= Gravel, SA= Sand, SB= Small Boulder
(2): Embeddedness.: Estimated cobble embeddedness in the unit is >35% = Y (yes).
(3): Bank ground cover: 3= 51-75% armored, 4= 76-100% armored

3.2 VEGETATION

3.2.1 Introduction

In this chapter, the current conditions of vegetation within Canyon Creek watershed were evaluated. The focus is on the analysis area, or the 59,578 acres under NFS administration. Quantitative analysis was designed to address the following vegetation attributes.

- Plant species composition at the levels of potential vegetation groups (PVGs) and plant association groups (PAGs)
- Forest structures that describe the stages of stand development
- Historic fire regimes that describe the frequency and severity of fire
- Live fuels condition classes that describe the degree of divergence in stand structure and composition from historic fire regimes

In addition to the effects of fire exclusion, this section presents a qualitative analysis of other important factors that have had an effect on the vegetation within the watershed, including timber harvest and insects and disease.

3.2.2 Species Composition

3.2.2.1 Watershed Scale

The topographically diverse watershed supports a high diversity of tree species; within the 59,578-acre analysis area, eleven tree species were encountered in the canopy layers (Table 3.37). Ponderosa pine and Douglas-fir were the most dominant. Ecologically responsive species, or those sensitive to disturbance, including quaking aspen, black cottonwood, and whitebark pine, were also present within the watershed.

Vegetation types of the Canyon Creek watershed are summarized into five broad categories: forested uplands, non-forested uplands, forested riparian zones, non-forested riparian zones, and non-vegetated lands. For a particular stand to be considered “forest,” it must contain a minimum of 10% tree canopy closure, as evaluated from aerial photography (Blue Mountain Mapping Standards 2002).

Table 3.37. Eleven tree species encountered within canopy layers and acreage they dominate within 59,578-acre analysis area.

Species	Scientific name	Elevational range (ft)	Acres in dominance	% of analysis area
Ponderosa pine	*Pinus ponderosa*	3,903 – 7,061	21,289	36%
Douglas-fir	*Pseudotsuga menziesii*	3,960 – 7,772	18,095	30%
Grand fir	*Abies grandis*	4,034 – 7,772	11,537	19%
Western juniper	*Juniperus occidentalis*	4,009 – 6,664	1,450	2%
Lodgepole pine	*Pinus contorta*	4,329 – 7,656	771	1%
Subalpine fir	*Abies lasiocarpa*	5,625 – 7,772	663	1%
Western larch	*Larix occidentalis*	4,041 – 6,970	335	1%
Quaking aspen	*Populus tremuloides*	3,903 – 5,960	1	<1%
Whitebark pine	*Pinus albicaulis*	7,093 – 7,550	0	0%
Englemann spruce	*Picea englemannii*	4,595 – 7,122	0	0%
Black cottonwood	*Populus balsamifera*	3,903 – 4,206	0	0%

Data collected from 1:12,000 color aerial photographs, Duck Creek Associates, Inc. in prep.

Canyon Creek watershed contains 73,954 acres, of which 59,578 (~81%) are within the analysis area (Table 3.38). Overall, 56,880 acres (95%) are within upland environments, 2,227 acres (4%) are within riparian zones and 470 acres (1%) are non-vegetated, including gravel mines, rock outcrops, or administrative lands.

Table 3.38. Five broad catergories of stands within the analysis area.

Vegetation category	Total acres within the analysis area	Percentage of analysis area	Percentage of entire watershed
Forested Uplands	52,176	88%	71%
Non-Forested Uplands	4,705	8%	6%
Forested Riparian Zones	2,028	3%	3%
Non-Forested Riparian Zones	199	<1%	<1%
Non-Vegetated/ Administrative Lands	470	1%	1%
Total Acres	59,578		81%

The analysis area represents 59,578-acre Malheur National Forest System lands, or 81% of the Canyon Creek watershed.

At the watershed scale, 21 potential vegetation groups (PVGs) were identified in the analysis area. Forested stands were assigned a plant association group (PAG) (USFS 2002b) (Map 3.10, Map 3.11), (Table 3.39).

Overall, Dry Upland Forest having the warm-dry plant association groups was the most common vegetation type in the watershed (Table 3.39). These forests were generally found in lower elevations, and were typified by a combination of ponderosa pine, Douglas-fir, and warm grand fir plant associations. Shrubland and Herbland (upland grasslands and meadows) communities were also prevalent within the watershed. A total of 3,220 acres were Upland Shrublands and 140 acres were Riparian Shrublands (6% and <1% of the analysis area, respectively). Upland Herblands composed approximately 2% of the analysis area (1,155 acres); approximately 60 acres of Riparian Herblands (i.e., meadows) were also encountered.

Table 3.39. Watershed-scale summary of 21 Potential Vegetation Groups (PVGs) and Plant Association Groups (PAGs) determined from PI data for 59,578-acre analysis area within Canyon Creek watershed.

Potential Vegetation Group (PVG)	Plant Association Group (PAG)	Acres	Percent of analysis area
Cold Upland Forest	Cold Dry	1,760	3.0%
Cold Upland Forest	Cool Dry	44	0.1%
Moist Upland Forest	Cool Moist	10,270	17.2%
Dry Upland Forest	Hot Dry	6,461	10.8%
Dry Upland Forest	Warm Dry	33,344	56.0%
Moist Woodland	Hot Moist	130	0.2%
Dry Woodland	Hot Dry	168	0.3%
Cold Upland Shrubland		439	0.7%
Moist Upland Shrubland		2,562	4.3%
Dry Upland Shrubland		549	0.9%
Cold Upland Herbland		168	0.3%
Moist Upland Herbland		919	1.5%
Dry Upland Herbland		68	0.1%
High SM* Riparian Forest	Cold High SM*	12	0.0%
High SM* Riparian Forest	Warm High SM*	256	0.4%
Moderate SM* Riparian Forest	Cold Moderate SM*	2	0.0%
Moderate SM* Riparian Forest	Warm Moderate SM*	26	0.0%
Low SM* Riparian Forest	Cold Low SM*	325	0.5%
Low SM* Riparian Forest	Warm Low SM*	1,407	2.4%
High SM* Riparian Shrubland		22	0.0%
Moderate SM* Riparian Herbland		41	0.1%
Low SM* Riparian Shrubland		47	0.1%
Moderate SM* Riparian Shrubland		71	0.1%
Low SM* Riparian Herbland		19	0.0%
Non Vegetated Land		430	0.7%
Administrative Land		40	0.1%
Total Acres		**59,578**	

Soil Moisture.

3.2.2.2 Forested Uplands

A total of 51,878 acres (87% of the analysis area) have upland forest vegetation potential and 298 acres (<1%) have potential for upland woodlands (Table 3.40). These upland forest-types make a transition across a wide elevational range and contain stands that are dominated by one of seven main species: ponderosa pine, Douglas-fir, grand fir, lodgepole pine, subalpine fir, western larch, and western juniper.

Overall, dry upland forest-types with warm-dry plant associations dominate approximately half the analysis area (Table 3.40); these stands are characterized by a transition from ponderosa pine and Douglas-fir co-dominated stands to a grand fir/Douglas-fir co-dominance.

Table 3.40. Potential vegetation groups (PVGs) and plant association groupings (PAGs) for forested upland types within the 59,580-acre analysis area.

Potential Vegetation Group (PVG)	Plant Association Group (PAG)	Total acres	Percent of forested upland vegetation	Elevational range (ft)		Dominant species*
Cold Upland Forest	Cold / Dry	1,760	3%	6,238	7,772	SA, DF, GF,LP, WL,
	Cool / Dry	44	<1%	5,881	6,935	LP
Moist Upland Forest	Cool / Moist	10,270	20%	4,595	7,752	GF, DF, LP, WL
Dry Upland Forest	Warm / Dry	33,344	64%	4,010	6,881	PP, DF, GF, WL
	Hot / Dry	6,461	12%	4,009	6,883	PP, DF
Moist Woodland	Hot / Moist	130	<1%	4,442	5,894	WJ
Dry Woodland	Hot / Dry	168	<1%	4,355	5,200	WJ
Total Forested Upland Types		**52,176**	**100%**	**4,009**	**7,772**	

**SA = Subalpine Fir; DF = Douglas-Fir; GF = Grand Fir; LP = Lodgepole Pine; WL = Western Larch; PP = Ponderosa Pine, WJ = Western Juniper*

Insects and disease are a visible disturbance factor within the forested uplands of the Canyon Creek watershed; severe infestations and damage have been recently documented within the watershed (Spiegel and Schmitt 2002). Mortality and decay to disease, particularly dwarf mistletoe, has led to increased fuel loading in many different forest types. Fuel loads from fallen- and standing-dead trees accompany living trees in decayed condition and a generally overstocked understory. This combination has led to an increase in vertical continuity of fuels and the increased likelihood of crown fires. See the *Insects and Disease* section of this chapter for further discussion on the conditions within the watershed.

3.2.2.3 Non-Forested Uplands

Approximately 8% of the analysis area is non-forested uplands (Table 3.41). Moist Upland Shrublands dominated by big mountain sagebrush (*Artemesia tridentata*) and curltail mountain mahogany (*Cercocarpus ledifolius*) typify the common shrubland plant communities. These communities are highly susceptible to encroachment by western juniper in fire-excluded areas (Paysen et al. 2000). Dry Upland Shrublands in hot-dry plant associations are present; these communities are dominated by stiff sagebrush (*Artemesia rigida*) and Sandberg's bluegrass (*Poa sandbergii).* Cold Upland Shrublands are also present, and are found in predominantly subalpine zones (ca. 6,500 feet).

Herblands are less common within the Canyon Creek watershed (Table 1.14). Moist Upland Herblands dominated by Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Agropyron spicatum*) are the most common grasslands. In upper elevations (ca. 6,500 feet), species including alpine elk sedge (*Carex geyeri*) and green fescue (*Festuca viridula*) typify these subalpine meadows and grasslands.

Table 3.41. Potential vegetation groups (PVGs) for 3,973 acres of non-forested upland vegetation within 59,578-acre analysis area.

Potential Vegetation Group (PVG)	Total acres	Percent of non-forested upland vegetation	Elevational range (ft)	
			Min.	Max.
Cold Upland Herblands	168	4%	6,227	7,457
Moist Upland Herblands	919	20%	3,990	6,444
Dry Upland Herblands	68	1%	4,364	4,846
Cold Upland Shrubland	439	9%	5,846	7,697
Moist Upland Shrubland	2,562	54%	4,203	6,450
Dry Upland Shrubland	549	12%	4,245	5,194
Total Non-Forest Upland Types	4,705	100%	3,990	7,697

3.2.2.4 Riparian Zones

Although riparian zones are a relatively minor contingent in land area within a watershed, they are essential components to properly functioning ecosystems, particularly in the arid and semi-arid environments of eastern Oregon. Linkages among plant species composition, stream channel structure and stability, groundwater hydrology, and nutrient cycling have been well documented (Dwire 2001, Otting 1998, Kauffman et al. 2002, and others). The proximity of water in riparian zones lends to a shift in species composition between xeric and mesic plant associations; soil moisture and groundwater table elevations are a key indicator of plant species composition (Dwire 2001, Elmore and Beschta 1987, Kauffman et al. 2002).

Plant species provide different functions for stream channels and instream habitat depending on a variety of factors, including stream gradient, floodplain width, channel type, etc. In the higher-gradient streams typically found in upper elevations, conifers provide essential inputs of large wood debris into streams, which in turn create instream structures that function in the development of deep pools and instream habitat.

In contrast, meandering streams in floodplain environments are dependent upon deep-rooted plant species such as sedges (*Carex* spp.) and rushes (i.e., *Juncus* spp.). These plants provide bank stability, catch fine sediments during flood events, increase groundwater infiltration rates, and retain coarse organic particulate matter critical in the maintenance of instream food webs (Brookshire 2001, Dwire 2001, Kauffman et al. *submitted*). Hardwood abundance provides essential shade to properly moderate extremes and fluctuations in water temperatures as well as provide key nutrient inputs from litterfall.

In the Canyon Creek watershed, the riparian vegetation is divided into two coarsely defined categories: Forested Riparian and Non-Forested Riparian Zones (Table 3.38).

3.2.2.5 Forested Riparian Zones

In addition to potential vegetation groups, broad plant association groupings have been defined for forested riparian zones (USFS 2002e). Soil moisture (SM) and temperature are the key indicators to describe the vegetation potential for riparian stands (USFS 2002e). Forested riparian stands within the analysis area are dominated by grand fir, Douglas-fir, ponderosa pine, western larch, or quaking aspen (*Populus tremuloides*).

Warm, low SM Forested Riparian stands are the most common plant association group (Table 3.42); these stands are associated with floodplain environments and low stream gradients. The tree species are typically a grand fir/Douglas-fir community type with a minor component of ponderosa pine. Common snowberry is prevalent in the understory along with hardwood species near the stream channel, predominantly willows (*Salix* spp.), red osier dogwood (*Cornus stolonifera*), and alders (*Alnus* spp.).

Other forested riparian plant association groups include cold, low-soil moisture-stands dominated by grand fir, lodgepole pine, and Englemann spruce with a minor component of Douglas-fir. These stands are typically found in narrow stream channel environments, cold air drainages and mid-elevation sites (ca. 5,500 feet); understory components include alder, currants (*Ribes* spp.), and Kentucky bluegrass (*Poa pratensis*).

Table 3.42. Potential vegetation groups (PVGs) and plant association groupings (PAGs) for forested riparian zones within 59,578-acres analysis area.

Potential Vegetation Group (PVG)	Plant Association Group (PAG)	Total acres	Percent of forested riparian zones	Elevational range (ft) Min.	Elevational range (ft) Max.
High SM* Riparian Forest	Cold, High SM	12	1%	6,253	6,253
	Warm, High SM	256	13%	5,694	6,453
Moderate SM Riparian Forest	Cold, Moderate SM	2	<1%	4,731	4,731
	Warm, Moderate SM	26	1%	5,346	6,259
Low SM Riparian Forest	Cold, Low SM	325	16%	4,952	5,730
	Warm, Low SM	1,407	69%	4,041	5,902
Total Forested Riparian Zones		**2,028**	**100%**		

SM = Soil Moisture

3.2.2.6 Non-Forested Riparian Zones

Shrublands comprised approximately two-thirds of the Non-Forested Riparian zones (Table 3.43). Of these riparian shrublands, half are classified as having moderate soil moisture vegetation types. Willows, alders, and red osier dogwood dominate these shrubland communities. Sedges, grasses (*Poa* spp.), and mesic forbs are common along the stream banks.

Among riparian herblands, sedge meadows are the most common vegetation group (Moderate SM Riparian Herbland, Table 3.43). These floodplain meadows are characterized by a sparse presence of ponderosa pine, Douglas-fir, grand fir, and lodgepole pine, with myriad of sedge and rush species that correspond with water table elevation.

The single largest meadow in the Canyon Creek watershed is found behind Canyon Meadows Dam. Spike rushes (*Eleocharis* spp.) dominate this 27.8-acre artificial meadow along with a minor component of currants (*Ribes* spp.). Although the dam is inactive and the floodgates have been permanently opened, complete inundations from rainfall and snowmelt are common because the dam structure remains in place.

Table 3.43. Potential vegetation groups (PVGs) for non-forested riparian zones within the 59,578-acre analysis area.

Potential Vegetation Group (PVG)	Total acres	Percent of forested riparian zones	Elevational range (ft)	
			Min.	Max.
Moderate SM* Riparian Herbland	41	21%	4,281	6,632
Low SM Riparian Herbland	19	9%	4,290	5,041
High SM Riparian Shrubland	22	11%	5,583	6,864
Low SM Riparian Shrubland	47	24%	3,903	4,992
Moderate SM Riparian Shrubland	71	35%	4,241	4,610
Total Non-Forested Riparian Zones	199	100%		

*SM = Soil Moisture

3.2.2.7 Non-Vegetated Lands

A total of 450 acres, or 1% of the analysis area, are classified as non-vegetative lands because the vegetation potential was determined to be marginal (i.e., less than 20% vegetated) or land dedicated to administrative uses (i.e., buildings or roads) (Table 3.44). Stands that were temporarily non-forested due to recent disturbance events, such as timber harvest, fire, or disease, were classified according to their potential vegetation (PVG) and not considered “non-vegetated lands” (USFS 2002e).

Table 3.44. Non-vegetated land within 59,578-acre analysis area.

Land type	Description	Total acres	% of non-vegetative land
Administrative Land	Buildings, Structures, Roads	38	8%
	Cultivated Land	3	1%
Non-Vegetated Land	Landform failure	11	2%
	Anthropogenically disturbed	6	<1%
	Rocky Land	391	87%
	Sand, shoreline, or interior	1	<1%
	Talus Land	20	4%
	Other Non-Vegetated	1	<1%
Total Non-Vegetated Land		450	100%

3.2.2.8 Quaking Aspen

Quaking aspen was encountered in 12 stands within the analysis area, two of which were dominated by aspen (Map 3.12). Although site-specific evaluations of aspen has not been conducted for this watershed analysis, the general trends of aspen within the Malheur National Forest involve a highly decadent overstory with very low levels of aspen regeneration. Two factors greatly influence this condition of aspen groves: 1) dense shading from an established conifer overstory (usually ponderosa pine), and/or 2) grazing by ungulates, particularly livestock. Properly constructed exclosures to prevent grazing pressures in other areas of the Malheur National Forest have been successful for aspen restoration as have removal of coniferous shade.

3.2.2.9 Cottonwoods

Three stands were identified from aerial photographs where cottonwoods were present (Map 3.12). Because cottonwoods are dependent on flood scouring for their success, their range is typically restricted to floodplain environments. Floodplain environments are less common in the analysis area on NFS lands than in the non-federal management areas. Thus much of the discussion and analysis of cottonwoods abundance was outside the scope of this watershed analysis.

3.2.2.10 Federally Listed Plant Species

The documented extent of federally listed plant species within the Canyon Creek watershed is limited. One stand containing the species *Thelypodium eucosmum* was found in the Byram Gulch area of the Canyon City subwatershed (Map 3.12). This species is listed as a Species of Concern under the Endangered Species Act (ESA) and Listed Threatened under Oregon ESA, and ranked second in rarity under the National and State Heritage Programs. The extent of distribution of other listed species within the watershed is not known. Increased biodiversity is one beneficial effect of restoring fire as a disturbance process.

3.2.2.11 Culturally Important Plants

While the Canyon Creek watershed may not be an area of concentrated plant use by nearby tribes, several culturally important plant species occur in small populations. Big huckleberry *(Vaccinium membranaceum*) is probably the most common plant species. Fire suppression, dense canopy cover in overstocked conifer stands, and intensive browse levels are all factors that limit the distribution of productive huckleberry patches, although the extent of the limitation has not been quantified.

Populations of chokecherry *(Prunus virginiana*) typically occur along smaller streams and primarily where rock outcrops or steep terrain limit browsing access by deer, elk and cattle. Because of the harsh environments, many of these plants may be too small to produce fruit (USFS 2002d).

Plants such as onions *(Allium spp*), biscuitroot *(Lomatium spp*), yampah *(Perideridia spp*), and bitterroot *(Lewisia redeviv*a), are found on open scab flats. Bitterroot tends to prefer dry, rocky sites with shallow soils and is the least common culturally important plant species, probably because its preferred habitat is uncommon. While most are not highly palatable to deer, elk and cattle, these root crops can suffer from overuse of scablands when large numbers of animals trample saturated soils and displace the roots. This effect tends to occur early in the growing season when vernal moisture is still present on many scabs (USFS 2002d).

3.2.2.12 Juniper Encroachment

Classifying potential vegetation types is problematic due to changes in vegetation composition and structure after decades of fire exclusion. Encroachment by western juniper is one example. PI data identified 87 stands representing ~1,450 acres containing ≥10% canopy cover dominated by western juniper (life form class "CJ," Blue Mountain Mapping Standards 2002). Further analysis from mirror stereoscopes indicated only about 300 acres were potentially true juniper woodland communities; the remaining approximately 1,150 acres were shrubland, grasslands, or hot-dry upland forest that had been severely encroached upon by western juniper (Table 3.45).

Table 3.45. 1,450 acres within analysis area dominated by ≥10% canopy cover of western juniper.

Potential Vegetation Group	Plant Association Group	Acres	Percent of total
Dry Upland Forest	Hot Dry	421	29%
Moist Upland Shrubland		455	31%
Moist Upland Herbland		240	17%
Dry Upland Herbland		37	3%
Moist Woodland	Hot Moist	130	9%
Dry Woodland	Hot Dry	168	12%
Total acres dominated by western juniper		1,450	

Prior to fire exclusion, the majority of the juniper-dominated forests were likely dominated by shrubs (31%) and dry upland forest (29%) (Table 3.45). In general, the juniper-invaded shrubland communities were those dominated by mountain big sagebrush and curl-leaf mountain mahogany. The dry upland forest types dominated by juniper had similar shrub compositions, with ponderosa pine in the overstory. This analysis is only a cursory examination of the degree of juniper encroachment upon non-woodland vegetation groups. With a long history of fire exclusion in the watershed, it is expected encroachment of other conifers (ponderosa pine and Douglas-fir) is likely in grasslands and shrublands. Ground-truth and landscape-level analyses on grazing intensities are recommended to ascertain the effects of conifer encroachment on traditionally non-forested ecosystems.

3.2.2.13 Subwatershed Scale

At the subwatershed scale, the majority (>50%) of the vegetation in the analysis area was within the Dry Upland Forest type within the warm-dry plant association groups (Table 3.46) excepting only Canyon City, Lower East Fork, and Upper East Fork subwatersheds.

Diversity of vegetation types (PVGs) was lowest in Vance Creek, with approximately 86% of the 4,169 acres in Dry Upland Forest (Table 3.46). Of these forest stands, 2,056 acres (~49% of the Vance Creek subwatershed) were warm-dry ponderosa pine plant associations; 605 acres (~15%) were Douglas-fir plant associations; and 430 acres (~10%) were hot-dry ponderosa pine plant associations (i.e., with mountain mahogany or mountain big sagebrush). A total of 326 acres, or about 8% of Vance Creek subwatershed, was temporarily non-forested due to timber harvest and was considered to have the potential for Dry Upland Forest, warm-dry plant associations.

In contrast, Canyon Meadows, Middle Fork, and Lower East Fork Canyon Creek had the highest diversity in vegetation types (15, 16, and 16, respectively, Table 3.46). In these subwatersheds, vegetation was largely composed of Moist Upland Forest vegetation groups, especially moist grand fir-dominated communities containing components of lodgepole pine. The diversity in riparian vegetation was also more pronounced in these subwatersheds. Riparian areas contained several soil moisture associations and vegetation types. In the upper elevations of these subwatersheds, riparian forest types ranged from high soil moisture to low soil moisture in lower elevations, and vegetation types transitioned from forest to meadows and moist shrub communities (i.e., *Alnus* spp., *Cornus* spp., *Salix* spp., etc.) along the elevational gradient. Finer resolution of riparian areas was not possible using PI data alone, and sufficient data as to plant association, seral stage, and overall riparian condition were not available.

Table 3.46. Distribution of 21 Potential Vegetation Groups (PVGs) and plant association groups (PAGs) within nine subwatersheds of 59,578-acre analysis area.

Potential Vegetation Group	***PAG***	***Berry Creek***		***Canyon City***		***Canyon Meadows***		***Fawn***		***Lower East Fork***		***Middle Fork Canyon Creek***		***Sugarloaf***		***Upper East Fork***		***Vance Creek***	
		Acres	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**
Cold Upland Forest	Cold Dry	339	5.9%	45	7.4%	88	1.0%					532	7.5%			756	9.4%		
Cold Upland Forest	Cool Dry	6	0.1%			38	0.4%												
Moist Upland Forest	Cool Moist	1,382	23.9%	41	6.8%	1,087	12.6%	79	0.7%	2,609	35.5%	1,459	20.6%	49	0.7%	3,563	44.2%		
Dry Upland Forest	Hot Dry	463	8.0%	236	38.9%	1,119	12.9%	1,679	15.3%	609	8.3%	506	7.1%	1,142	16.5%	246	3.1%	462	11.1%
Dry Upland Forest	Warm Dry	2,891	50.1%	240	39.6%	5,825	67.3%	7,022	64.1%	2,861	38.9%	3,910	55.2%	4,657	67.4%	2,804	34.8%	3,134	75.2%
Moist Woodland	Hot Moist							12	0.1%					91	1.3%	26	0.3%		
Dry Woodland	Hot Dry									71	1.0%	5	0.1%	91	1.3%				
Cold Upland Shrubland		130	2.2%	3	0.5%	60	0.7%			1	0.0%	170	2.4%	7	0.1%	68	0.9%		
Moist Upland Shrubland		56	1.0%	29	4.7%	50	0.6%	1,683	15.4%	149	2.0%	81	1.1%	264	3.8%			250	6.0%
Dry Upland Shrubland										465	6.3%	6	0.1%	77	1.1%				
Cold Upland Herbland		6	0.1%			12	0.1%			26	0.4%	36	0.5%			88	1.1%		
Moist Upland Herbland		156	2.7%	12	1.9%	51	0.6%	70	0.6%	244	3.3%	77	1.1%	211	3.1%	1	0.0%	98	2.4%
Dry Upland Herbland										31	0.4%			37	0.5%				
High SM Riparian Forest	Cold High SM															12	0.2%		
High SM Riparian Forest	Warm High SM	12	0.2%			24	0.3%			23	0.3%	62	0.9%			135	1.7%		
Moderate SM Riparian Forest	Cold Moderate SM									2	0.0%								
Moderate SM Riparian Forest	Warm Moderate SM					1	0.0%			24	0.3%	2	0.0%						
Low SM Riparian Forest	Cold Low SM					61	0.7%			36	0.5%	72	1.0%			156	1.9%		
Low SM Riparian Forest	Warm Low SM	182	3.2%			147	1.7%	348	3.2%	53	0.7%	106	1.5%	270	3.9%	97	1.2%	202	4.9%
High SM Riparian Shrubland						2	0.0%					6	0.1%			14	0.2%		
Moderate SM Riparian Herbland						32	0.4%			3	0.0%	5	0.1%			1	0.0%		
Low SM Riparian Shrubland								20	0.2%			4	0.1%					23	0.6%
Moderate SM Riparian Shrubland								36	0.3%	35	0.5%								
Low SM Riparian Herbland						9	0.1%	4	0.0%	6	0.1%								
Non Vegetated Land		155	2.7%	2	0.3%	14	0.2%	6	0.1%	108	1.5%	40	0.6%	9	0.1%	96	1.2%		
Administrative Land						37	0.4%	3	0.0%					0	0.0%				
Total Acres		5,777		607		8,657		10,962		7,358		7,078		6,907		8,062		4,169	

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3.2.2.14 Wildland/Urban Interface (WUI)

Due to its position in the lower elevations, the vegetation types within the wildland/urban interface (WUI) under NFS management (34,460 acres) had higher concentrations of the Dry Upland Forest types than did the area outside the WUI (Map 3.10, Table 3.47). Dry Upland Forest in the warm-dry plant associations (i.e., ponderosa pine, Douglas-fir, and warm grand fir types) comprised approximately two-thirds of the land area within the WUI (22,308 acres), and the WUI contained two-thirds of all of the land area of Dry Upland Forest within the Canyon Creek watershed. Of these warm-dry plant associations, ponderosa pine-dominated stands encompassed 11,874 acres (34%), Douglas-fir dominated stands occupied 7,738 acres (~23% of the WUI), grand fir was dominant in 2,040 acres (~6%), and 49 acres (1%) was dominated by western larch for a total of 22,308 forested acres within the WUI analysis area. The remaining 607 acres (~2%) were temporarily non-forested lands from recent harvest or fire.

A total of 12,152 acres were classified as non-forest within the WUI, the majority of which were upland shrublands. Approximately 86% of the shrublands found in the entire analysis area were located within the WUI. The majority of these shrublands (1,010 acres) were dominated by mountain big sagebrush with an average canopy cover of approximately 18%; mountain mahogany-dominated shrublands averaged approximately 29% cover and comprised 450 acres of the WUI. Shrublands with mixed compositions (e.g., sagebrush, bitterbrush, and mountain mahogany) comprised 893 acres of the WUI. A total of 540 acres were identified as hot-dry Upland Shrubland vegetation groups; these shrublands are typified by their presence of low sagebrush (*Artemesia arbuscula*) and stiff sagebrush (*Artemesia rigida*) intermixed with bare rock and shallow soils. Approximately 455 acres determined to have Upland Shrubland potential also contained at least a 10% co-dominance of western juniper (see the *Juniper Encroachment* section of this chapter).

Table 3.47. Potential Vegetation Groups (PVGs) and plant association groups (PAGs)within 59,578-acre analysis area.

		NFS lands within Wildland/ Urban Interface (WUI)		***NFS lands outside WUI***		***Entire analysis area***	
Potential Vegetation Group	**PAG**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Cold Upland Forest	Cold Dry	137	0.4%	1,623	6.5%	1,760	3.0%
Cold Upland Forest	Cool Dry	6	0.0%	38	0.2%	44	0.1%
Moist Upland Forest	Cool Moist	1,412	4.1%	8,858	35.3%	10,270	17.2%
Dry Upland Forest	Hot Dry	5,206	15.1%	1,255	5.0%	6,461	10.8%
Dry Upland Forest	Warm Dry	22,309	64.7%	11,035	43.9%	33,344	56.0%
Moist Woodland	Hot Moist	103	0.3%	26	0.1%	130	0.2%
Dry Woodland	Hot Dry	162	0.5%	5	0.0%	168	0.3%
Cold Upland Shrubland		127	0.4%	312	1.2%	439	0.7%
Moist Upland Shrubland		2,383	6.9%	179	0.7%	2,562	4.3%
Dry Upland Shrubland		533	1.6%	16	0.1%	549	0.9%
Cold Upland Herbland		6	0.0%	162	0.6%	168	0.3%
Moist Upland Herbland		520	1.5%	399	1.6%	919	1.5%
Dry Upland Herbland		68	0.2%	0	0.0%	68	0.1%
High SM Riparian Forest	Cold High SM*	0	0.0%	12	0.0%	12	0.0%
High SM Riparian Forest	Warm High SM	0	0.0%	256	1.0%	256	0.4%
Moderate SM Riparian Forest	Cold Moderate SM	0	0.0%	2	0.0%	2	0.0%
Moderate SM Riparian Forest	Warm Moderate SM	1	0.0%	26	0.1%	26	0.0%
Low SM Riparian Forest	Cold Low SM	58	0.2%	267	1.1%	325	0.5%
Low SM Riparian Forest	Warm Low SM	1,069	3.1%	338	1.3%	1,407	2.4%
High SM Riparian Shrubland		0	0.0%	22	0.1%	22	0.0%
Moderate SM Riparian Herbland		39	0.1%	2	0.0%	41	0.1%
Low SM Riparian Shrubland		43	0.1%	4	0.0%	47	0.1%
Moderate SM Riparian Shrubland		54	0.2%	17	0.1%	71	0.1%
Low SM Riparian Herbland		19	0.1%	0	0.0%	19	0.0%
Non Vegetated Land		166	0.5%	264	1.1%	430	0.7%
Administrative Land		40	0.1%	0	0.0%	40	0.1%
Total Acres		34,460		25,118		59,578	

**Soil Moisture*

3.2.3 Structure: Stages of Stand Development

3.2.3.1 Watershed and Subwatershed Scale

A total of 12 structural classes were identified in the 59,578-acre analysis area. (Map 3.13, Table 3.48). Structural classifications for upland and riparian forest types were based upon PI data using methodology presented by Powell (2001); woodland structural classifications were made using methodology following ICBEMP (2000) and Duck Creek Associates (*in preparation*). Structural determinations follow PVG classifications defined in the *Species Composition* section of this chapter (Powell 2001).

Table 3.48. Distribution of 12 structural classes found within 59,578-acre analysis area.

Structural class	Description	Acres	Percent of analysis area
OFMS	Old Forest Multi Strata	10,085	16.9%
OFSS	Old Forest Single Stratum	201	0.3%
SECC	Stem Exclusion Closed Canopy	3,871	6.5%
SEOC	Stem Exclusion Open Canopy	21,529	36.1%
SI	Stand Initiation	332	0.6%
UR	Understory Regeneration	28	0.0%
YFMS	Young Forest Multi Strata	17,064	28.6%
WOMS	Woodland Old Multi Strata	152	0.3%
WSE	Woodland Stem Exclusion	145	0.2%
BG	Bare Ground	796	1.3%
NF	Non-Forested Land	5,334	9.0%
ADM	Administrative Land	40	0.1%
Total Acres		59,578	

At the watershed scale, the majority of the vegetation was in stem exclusion, open canopy (SEOC) or young forest, multi-strata (YFMS) structural stages. A total of 21,529 acres (36% of the analysis area) were SEOC and 17,064 (~29%) were YFMS. Approximately 17% of the analysis area was considered old forest, with 10,085 acres having old forest, multi-strata (OFMS) and 201 acres within the old forest single stratum stage (OFSS).

At the subwatershed scale, the majority of the old growth forest (OFSS and OFMS) was found in the Sugarloaf subwatershed (2,652 acres, or ~38% of the Sugarloaf subwatershed) (Table 3.49). These old forest stands were predominantly composed of Dry Upland Forest with warm-dry plant associations, including ponderosa pine (1,263 acres), Douglas-fir (739 acres), and warm, grand fir types (117 acres). Old-growth Dry Upland Forest within the hot-dry plant associations was also found within Sugarloaf subwatershed. Approximately 297 acres of old-growth ponderosa pine were found (240 acres within OFMS and 57 within OFSS), primarily within the ponderosa pine/ mountain big sagebrush and mountain mahogany plant associations. An additional ~35 acres dominated by hot/dry ponderosa pine plant associations were determined to be old-growth structure. These sites have been altered through encroachment by western juniper. Within riparian zones, Sugarloaf contained 178 acres of old-structured grand fir and 23 acres dominated by Douglas-fir within the Low Soil Moisture Riparian Forest Potential Vegetation Group (Table 3.49).

Lower East Fork subwatershed also contained a large area of old growth forest. A total of 1,718 acres (~23% of the Lower East Fork subwatershed) composed primarily of old forest, multi-strata, Dry Upland Forest within the warm-dry plant associations were encountered in Lower East Fork. These forests were dominated by Douglas-fir (893 acres, or 12% of Lower East Fork subwatershed), ponderosa pine (439 acres, or ~6%), and grand fir (361 acres, or ~5%).

In contrast, the Canyon Meadows subwatershed contained the highest proportion and most land area within the stem exclusion phase[11]. A total of 5,409 acres (63% of Canyon Meadows land area) were considered stem exclusion open canopy (SEOC) and 1,339 acres (15% of Canyon Meadows) were within the stem exclusion closed canopy (SECC) structural stage. The majority of these stands were contiguous across the subwatershed, with patchy areas containing either younger forest (YFMS) or old forest structure (OFMS or OFSS). The vegetation types were predominantly Dry Upland Douglas-fir plant communities (2,305 acres, or 26.5% of the Canyon Meadows subwatershed). Warm grand fir types were also prevalent, comprising 1,441 acres (~16% of Canyon Meadows), as were warm-dry ponderosa pine plant associations (1,065 acres or ~12% of Canyon Meadows).

11 Recent comments generated during peer-review with Forest Service silviculturists suggest classifications within the Stem Exclusion Open Canopy phase of Canyon Meadows may also include a fair component of Young Forest Multi-Strata structure. PI data indicated canopy closure in the overstory was below 10%, suggesting a non-viable overstory. Upon further review, it is likely more than 3 tree layers were present: Overstory canopy, a medium-tall canopy, a pole-sized regeneration layer, and a seedling layer. Due to the constraints applied by the mapping standards, photo interpretation has likely consolidated the two mid-story layers into one, resulting in the classification of a non-viable overstory combined with a very dense mid-story (of a single, averaged size class). Hence, Stem Exclusion Open Canopy stands in Canyon Meadows could also be considered Young Forest Multi –Strata. Further remote-sensing and ground truth analysis is recommended to elucidate the stand-specific structure in this area (Uebler et al. pers. comm.*).*

Table 3.49. The distribution of the 12 structural classes for each of nine subwatersheds within analysis area.

Structural Class and Description		***Berry Creek***		***Canyon City***		***Canyon Meadows***		***Fawn***		***Lower East Fork***		***Middle Fork Canyon Creek***		***Sugarloaf***		***Upper East Fork***		***Vance Creek***	
		Acres	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***
OFMS	Old Forest Multi Strata	883	15%	86	14%	572	7%	1,862	17%	1,718	23%	847	12%	2,582	37%	1,012	13%	523	13%
OFSS	Old Forest Single Stratum					7	0%					3	0%	70	1%	121	2%		
SECC	Stem Exclusion Closed Canopy	264	5%	45	7%	1,339	15%	902	8%	227	3%	571	8%	250	4%	159	2%	114	3%
SEOC	Stem Exclusion Open Canopy	2,403	42%	208	34%	5,459	63%	2,233	20%	1,858	25%	3,890	55%	1,121	16%	3,248	40%	1,110	27%
SI	Stand Initiation	185	3%			2	0%	39	0%	3	0%	3	0%	87	1%			13	0%
UR	Understory Regeneration	12	0%					2	0%			3	0%	6	0%			4	0%
YFMS	Young Forest Multi Strata	1,528	26%	224	37%	967	11%	3,859	35%	2,412	33%	1,220	17%	1,965	28%	3,181	39%	1,708	41%
WOMS	Woodland Old Multi Strata													152	2%				
WSE	Woodland Stem Exclusion							12	0%	71	1%	5	0%	30	0%	26	0%		
BG	Bare Ground					44	1%	231	2%			109	2%	37	1%	48	1%	326	8%
NF	Non-Forested Land	502	9%	45	7%	230	3%	1,819	17%	1,068	15%	425	6%	606	9%	268	3%	371	9%
ADM	Administrative Land					37	0%	3	0%					0	0%				
	Total Acres	5,777		607		8,657		10,962		7,358		7,078		6,907		8,062		4,169	

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3.2.3.2 Wildland/Urban Interface (WUI)

The WUI contains a generally higher proportion of old growth forest structure (OFMS and OFSS) than the Canyon Creek watershed as a whole) (Map 3.13, Table 3.50). Excluding the 1,108 acres of old growth structure within the wilderness designation, the WUI contains 5,182 acres (~15% of the WUI) of old growth, or approximately equal in proportion to the rest of the watershed. As is the case in the entire watershed, the majority of the stand structure within the WUI was within the stem exclusion phase (SEOC and SECC) or young forest (YFMS). Considering PVGs within the WUI were biased toward warmer, drier upland forests (i.e., ponderosa pine plant associations) (Table 3.50), the prevalence of stem exclusion and young forest structural classes suggest the WUI contains a higher proportion of overstocked stands than the watershed as a whole. Further discussion on the consequences of this overstocking is discussed in later sections and chapters.

Table 3.50. Twelve structural classes defined for vegetation contained within boundaries of 59,578-acre analysis area.

		NFS lands within Wildland/Urban Interface (WUI)		NFS lands outside WUI		Entire analysis area	
Structural class	**Description**	**Acres**	**% area**	**Acres**	**% area**	**Acres**	**% area**
OFMS	Old Forest Multi Strata	6,291	18.3%	3,794	15.1%	10,085	16.9%
OFSS	Old Forest Single Stratum	77	0.2%	124	0.5%	201	0.3%
SECC	Stem Exclusion Closed Canopy	2,352	6.8%	1,519	6.0%	3,871	6.5%
SEOC	Stem Exclusion Open Canopy	11,720	34.0%	9,809	39.1%	21,529	36.1%
SI	Stand Initiation	246	0.7%	86	0.3%	332	0.6%
UR	Understory Regeneration	25	0.1%	3	0.0%	28	0.0%
YFMS	Young Forest Multi Strata	8,878	25.8%	8,185	32.6%	17,064	28.6%
WOMS	Woodland Old Multi Strata	152	0.4%	0	0.0%	152	0.3%
WSE	Woodland Stem Exclusion	113	0.3%	32	0.1%	145	0.2%
BG	Bare Ground	607	1.8%	188	0.7%	796	1.3%
NF	Non-Forested Land	3,957	11.5%	1,377	5.5%	5,334	9.0%
ADM	Administrative Land	40	0.1%	0	0.0%	40	0.1%
	Total acres	34,460		25,118		59,578	

3.2.4 Fire Regimes: Frequency and Severity of Historic Fire

Fire regimes were assigned for each stand within the analysis area (Duck Creek Associates, *in prep.*) (Map 3.15, Table 3.51). One of five general fire regimes was assigned to each polygon, based upon the PVGs and PAGs of each stand (USFS Malheur National Forest Fire Management Plan).

Table 3.51. Five broadly-based fire regimes for describing frequency and severity of fire under natural, non-excluded conditions (i.e., historical fire regimes).

Fire regime	Description	Mean Fire Return Interval (MFRI) (years)	Number of acres	% of analysis area
I	Frequent fires of low severity (not stand replacing fires)	<35	15,637	26.2%
II	Frequent fires of high severity (stand replacing fire)	<35	2,907	4.9%
III	Mixed return intervals of mixed severity.	35-100	27,604	46.3%
IV	Long return interval of high severity (stand replacing fires).	100-200	11,758	19.7%
V	Very long return interval of high severity (stand replacing fires)	>200	1,671	2.8%
	Total Acres		59,578	

Source: Adapted from the Malheur National Forest Fire Management Plan and PI data.

3.2.4.1 Watershed and Subwatershed Scale

Fire regimes were assigned on the basis of potential vegetation (i.e., PVGs). The majority (73%) of the analysis area contained stands having fire regimes I and III (Table 3.52). Long return intervals (fire regimes IV and V) were most abundant in the higher elevations and encompassed ~23% of the analysis area. About 5% of the analysis area had a fire regime characterized by frequent stand-replacement fires typical of grasslands and shrublands (fire regime II).

In general (but not entirely), Dry Upland Forest in the warm-dry plant association groups was divided between fire regimes I and III. Ponderosa pine-dominated stands (i.e., ponderosa pine/pinegrass plant associations) typify fire regime I. Historically, these stands had a fire regime characterized by the presence of frequent low-intensity surface fires with a mean fire return interval of 8-15 years. These frequent fires resulted in a landscape typified as an uneven-aged mosaic of even-aged stands (Agee 1994). Most stands under this regime would be single-aged, would typically be quite small (0.25 to 2 acres), and overstory tree densities were low. Downed wood debris was low and there was vertical separation between surface and canopy fuels. Species were well adapted to survive with the occurrence of the frequent low intensity surface fires. Following fires, fuel re-accumulations were quite rapid and largely consisted of pine litter and perennial grasses. Fuels moisture falls below a threshold of combustion early in the summer and remain so for the duration of the season. As a result, fire recurrence would be possible only one to two years following fire.

Fuel continuity and productivity is limiting in ponderosa pine stands located on shallow, rocky soils with an understory of non-sprouting species such as curl-leaf mountain-mahogany, stiff sagebrush, and low sagebrush. These plant associations were classified as a subset of fire regime III (fire regime III-a), primarily because the presence of these non-sprouting shrub species suggests longer fire return intervals than what would typify a fire regime I community (Agee 1994). In these stands a fire regime typified as a moderate return interval (~35 years) with low intensity surface fire would best describe historic fire regimes.

Douglas-fir and warm-dry grand fir plant associations (life forms CD and CW) were classified as having a fire regime of III. This is a complex fire regime typified by relatively frequent (~35 year MFRI) surface fires with stand-replacing fires every ~100 years. Wildland fires that occur in these forests will usually burn as understory surface fires except under the most severe fire weather conditions when conditions are suitable for severe stand-replacement fires. This fire pattern often created a forest with multiple age classes within the same stand. Landscape heterogeneity would also be quite high. Fuel moisture contents remain high later in the fire season than those of fire regimes I and II. Often forests with a fire regime III will occupy north-aspect slopes while forests on adjacent south slopes have a fire regime of I (the Vance Creek subwatershed is a prime example of this pattern).

Approximately 5% of the analysis area was classified with a fire regime II: frequent fires of high severity (stand replacing fire). These are productive grasslands and shrublands at low elevations. Plant communities dominated by mountain big sagebrush, bluebunch wheatgrass, and Idaho fescue would typify this fire regime. In addition, riparian meadows occupying broad floodplains surrounded by ponderosa pine forest would have this fire regime. Perennial grasses would be the dominant fuel carrying fires in these communities. Neither fuels nor fuel moisture contents limit fire spread for much of the fire season. Fuels loads and continuity rapidly recover given the adaptations of the perennial grasses to rapidly re-grow in the years following fire (Kauffman et al., 1997). Shrubs recover in these sites via re-sprouting or rapid reinvasions from seeds. Colonization by exotic species alters how these stands function with respect to fire. Currently, no data are available as to the content of non-native species in this fire regime for the analysis area.

At higher elevations within the analysis area, snow cover increases while forest (and fuel) productivity decreases. Forests are dominated subalpine fir, lodgepole pine and Engelmann spruce. In these forests, fire regimes fall under a long return interval (>100 years) with severe, stand replacing fires (fire regimes IV and V). Because these stands have such a long fire return interval, stands can contain a variety of structural stages, depending on the age since disturbance. In areas where the forest is continuous with few natural fire breaks (such as rock outcrops), patch-size is usually quite large in area and stands within a patch are typically of the same age. In the highest elevations of the Canyon Creek watershed, rock outcrops help to define small patches.

In fire regimes I and III, tree species have adapted to survive surface fires (i.e., thick bark, self pruning). In contrast, trees in fire regimes IV and V possess adaptations facilitating survival with long return intervals (i.e., thin-bark, no self pruning, shade tolerance, etc). While there have been dramatic changes in the structure and composition of plant communities with historical fire regimes of I – III, there are few differences in stands of fire regimes IV and V (i.e., these stands are not out of the range of natural variability due to land use or fire exclusion). Recently, Keane et al. (2002) described how some landscapes in the Intermountain West have been altered due to fire exclusion. Time since disturbance is an important factor in evaluating the effects of fire exclusion, and it is difficult to evaluate the effects with long return interval fire regimes (IV and V) when fire has been excluded through management for only 1 fire return interval (i.e., since ~1850).

Another plant community under fire regime IV in central Oregon would include those few areas dominated by "old growth" western juniper (i.e., woodlands). In these old stands, fuel loads limit the spread of fire. Only under the most severe of fire weather conditions can fires spread through these stands. It is important to separate these western juniper stands from those where land use and fire exclusion has resulted in the invasion and dominance of juniper within stands formerly dominated by grassland or shrublands.

In summary, the periodicity of fires and their ecological severity is a continuum in western landscapes. Given the heterogeneity in vegetation composition and structure of the Canyon Creek watershed, five categorical fire regimes may be too simplistic for all plant community types within the watershed. This is particularly true for the land areas with fire regime III. Within this regime, there could be "sub-regimes" of moderate return interval stand-replacing fires (35-100 years). This likely would characterize the quaking aspen stands of the Strawberry Mountains. In addition, there are stands with moderate-return intervals (A MFRI of >30 years) and low severity surface fires, such as those ponderosa pine sites where fuel productivity and continuity is limiting by shallow, rocky soils (fire regime III-a). Nevertheless, for the majority of sites within the watershed, historical fire regimes are likely reasonably represented in this analysis.

Table 3.52. Distribution of 5 fire regimes for each of 26 Potential Vegetation Groups (PVGs) and Plant Association Groups (PAGs) within 59,578 acre analysis area.

		Fire Regime I		Fire Regime II		Fire Regime III		Fire Regime IV		Fire Regime V	
PVG	PAG	Acres	% Area	Acres	% Area	Acres	% Area	Acres	% Area	Acres	% Area
Cold Upland Forest	Cold Dry							519	0.9%	1,241	2.1%
Cold Upland Forest	Cool Dry							44	0.1%		
Moist Upland Forest	Cool Moist							10,270	17.2%		
Dry Upland Forest	Hot Dry	4,007	6.7%			2,455	4.1%				
Dry Upland Forest	Warm Dry	11,593	19.5%			21,751	36.5%				
Moist Woodland	Hot Moist					103	0.2%	26	0.0%		
Dry Woodland	Hot Dry							168	0.3%		
Cold Upland Shrubland				35	0.1%			404	0.7%		
Moist Upland Shrubland				2,027	3.4%	535	0.9%				
Dry Upland Shrubland						549	0.9%				
Cold Upland Herbland				159	0.3%			9	0.0%		
Moist Upland Herbland				581	1.0%	338	0.6%				
Dry Upland Herbland				37	0.1%	31	0.1%				
High SM Riparian Forest	Cold High SM							12	0.0%		
High SM Riparian Forest	Warm High SM							256	0.4%		
Moderate SM Riparian Forest	Cold Moderate SM							2	0.0%		
Moderate SM Riparian Forest	Warm Moderate SM							26	0.0%		
Low SM Riparian Forest	Cold Low SM					325	0.5%				
Low SM Riparian Forest	Warm Low SM					1,407	2.4%				
High SM Riparian Shrubland								22	0.0%		
Moderate SM Riparian Herbland						41	0.1%				

		Fire Regime I		Fire Regime II		Fire Regime III		Fire Regime IV		Fire Regime V	
PVG	***PAG***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***
Low SM Riparian Shrubland				47	0.1%						
Moderate SM Riparian Shrubland						71	0.1%				
Low SM Riparian Herbland				19	0.0%						
Non Vegetated Land										430	0.7%
Administrative Land		38	0.1%	3	0.0%						
Total Acres		**15,637**		**2,907**		**27,604**		**11,758**		**1,671**	

Table 3.53. Fire regimes found for Plant Vegetation Groups and plant association groups (PAGs) within 34,460-acre Wildland/Urban Interface (WUI) on NFS lands.

		Fire Regime I		Fire Regime II		Fire Regime III		Fire Regime IV		Fire Regime V	
PVG	PAG	Acres	% Area	Acres	% Area	Acres	% Area	Acres	% Area	Acres	% Area
Cold Upland Forest	Cold Dry							47	<1%	90	<1%
Cold Upland Forest	Cool Dry							6	<1%		
Moist Upland Forest	Cool Moist							1,412	4%		
Dry Upland Forest	Hot Dry	3,362	10%			1,844	5%				
Dry Upland Forest	Warm Dry	9,682	28%			12,626	37%				
Moist Woodland	Hot Moist					103	<1%				
Dry Woodland	Hot Dry							162	<1%		
Cold Upland Shrubland				7	<1%			119	<1%		
Moist Upland Shrubland				1,926	6%	457	1%				
Dry Upland Shrubland						533	2%				
Cold Upland Herbland				6	<1%			1	<1%		
Moist Upland Herbland				450	1%	69	<1%				
Dry Upland Herbland				37	<1%	31	<1%				
Moderate SM Riparian Forest	Warm Moderate SM							1	<1%		
Low SM Riparian Forest	Cold Low SM					58	<1%				
Low SM Riparian Forest	Warm Low SM					1,069	3%				
Moderate SM Riparian Herbland						39	<1%				
Low SM Riparian Shrubland				43	<1%						
Moderate SM Riparian Shrubland						54	<1%				
Low SM Riparian Herbland				19	<1%						
Non Vegetated Land										166	<1%

		Fire Regime I		Fire Regime II		Fire Regime III		Fire Regime IV		Fire Regime V	
PVG	**PAG**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**	**Acres**	**% Area**
Administrative Land		38	<1%	3	<1%						
Total Acres (% of WUI)		**13,082**	**38%**	**2,491**	**7%**	**16,883**	**49%**	**1,748**	**5%**	**256**	**1%**

3.2.4.2 Wildland/Urban Interface (WUI)

Within the WUI, fire regimes were biased toward I and III, or those regimes having shorter return intervals with low to mixed severity fires (Table 3.53, Map 3.15). Warm-dry ponderosa pine stands typify the 9,682 acres having fire regime I. The 12,626 acres having a longer return interval (fire regime III) contain mostly Douglas-fir and grand fir communities with a fair component (2,793 acres) of ponderosa pine stands having longer return intervals (i.e., ponderosa pine/ mountain mahogany plant associations).

3.2.5 Live Fuels Condition Classes

The purpose of this analysis was to evaluate the current condition of the vegetation structure and species composition (live fuels) with respect to historic fire regimes. Although live fuels alone are not sufficient for describing fire risk at local and landscape scales, they offer insight as to ecosystem-level changes as a result of fire exclusion and management practices. Dead and downed fuels were not considered in the analysis because data were not available.

In general, live fuels condition classes were assigned according to modified criteria described in the Malheur National Forest Fire Management Plan, and each stand was evaluated as to the degree of departure from historic fire return intervals. Grasslands and meadows were not considered in this analysis because it was not possible to detect shifts in species composition or biomass structure using aerial photographs and no ground-truth data were available. Therefore, 906 acres of upland and riparian herblands (grasslands and meadows) were excluded from the analysis because data were unavailable to properly evaluate condition.

By definition, it is hard to understand why all the stands in fire regime I do not have live fuels with a condition class 3 because it is possible that as many as 10 fire cycles have been eliminated in low elevation ponderosa pine stands. In addition, second growth stands where the forest has developed without surface fires in their history have a structure far outside the historical range of variability (high stand density, high levels of ladder fuels, surface fuels, etc.).

Table 3.54. Description of three live fuels condition classes used to evaluate how stands are functioning within their historic fire regimes.

Condition class	Attributes	Example management options
Live Fuels Condition Class 1	Fire regimes are within or near an historical range. The risk of losing key ecosystem components is low. Fire frequencies have departed from historical frequencies (either increased or decreased) by no more than one return interval. Vegetation attributes (species composition and structure) are intact and functioning within an historic range.	Where appropriate, these areas can be maintained within the historic fire regime by treatment such as prescribed fire or wildland fire use.
Live Fuels Condition Class 2	Fire regimes have been moderately altered from their historic range. The risk of losing key ecosystem components has increased to moderate. Fire frequencies have departed from historic frequencies by more than one return interval. This change results in moderate changes to one or more of the following: fire size. Frequency, intensity, severity, or landscape pattern. Vegetation attributes have been moderately altered from their historic ranges.	Where appropriate, these areas may need moderate levels of restoration treatments, such as wildland fire use, prescribed fire, and hand or mechanical treatments, to restore historic composition and structure and fire regimes (particularly fire regime I).
Live Fuels Condition Class 3	Fire regimes have been considerably altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed by multiple return intervals. This change results in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape pattern.	Where appropriate, these areas need intensive degrees of restoration treatments, such as stage prescribed burning, hand or mechanical treatments. These treatments may be necessary before any wildland fire use is used to restore the historical fire regime.

Source: Adapted from the Malheur National Forest Fire Management Plan, USFS Agency Comprehensive Strategy

Stands most in need of restoration would include those in live fuels condition classes 2 and 3. Stands in condition class 2 can be most easily restored at lower cost that in condition class 3. As a simplification, fuels in ponderosa pine forest in condition class 2 may be effectively reduced via prescribed burning. Stand restoration, particularly in second-growth stands would require thinning to historical stand densities prior followed by the establishment of a prescribed understory burning. The composition and structure of downed and dead fuels is necessary before any concrete recommendations can be made (see *Chapter 5-6*).

Fewer stands in fire regimes III and IV are found with live fuels condition classes 2 and 3. While few stands may be outside their historical range of variability, landscapes are altered in that there are likely fewer naturally established young post-fire stands. However, young stands exist in areas of timber harvest, but these likely have a different size and structure and higher fuel loads than stands established from recent fire.

3.2.5.1 Watershed and Subwatershed Scale

Approximately half of the analysis area had stand composition and structure that was considered to be functioning outside its historic fire regime (Map 3.16, Table 3.55). A total 25,767 acres (43% of the analysis area) had live fuels conditions that were "moderately altered" from historic fire regimes (condition 2) and 5,661 acres had been "considerably altered" (condition 3) in composition and structure from what would be considered historical conditions. These 31,428 acres (or ~53% of the analysis area) are considered to have moderate to severe alterations from historic fire regimes, and it is probable these stands would support uncharacteristically severe fires with elevated levels of mortality (see *Chapters 4, 5-6*).

Table 3.55. Number of acres under each live-fuels condition class within analysis area.

Condition class	***Total acres***	***% Of analysis area***
Condition 1	27,203	46%
Condition 2	25,767	43%
Condition 3	5,661	10%
Administrative Lands (not evaluated)	40	<1%
Grasslands (not evaluated)	906	2%
Total Acres	**59,578**	

At the subwatershed scale, Fawn and Sugarloaf comprise the majority of acres and highest proportion of condition 3 stands (1,679 and 1,650 acres, respectively) (Table 3.56). In both Fawn and Sugarloaf, the majority of the condition 3 stands were warm-dry ponderosa pine stands in the young forest multi-strata (YFMS) structural stage (650 acres in Fawn and 395 acres in Sugarloaf). Old forest multi-strata (OFMS) stands with very high levels of overstocking (condition 3) were also prevalent; 375 and 355 acres were within the OFMS in Fawn and Sugarloaf, respectively. Both of these multi-strata stand structures contained a high proportion of shade-tolerant understory poles and saplings and were markedly altered from what would be expected under their historic fire regime (regime I). A total of 537 acres within Sugarloaf and 133 acres in Fawn had condition 3 stands due to severe degrees of juniper encroachment. A synthesis of how condition classes relate to the risk of catastrophic fire is discussed in *Chapter 5-6*.

Table 3.56. Number of acres and proportion of each subwatershed having different live fuels condition classes within analysis area.

	Condition 1		Condition 2		Condition 3	
Subwatershed name	**Acres**	**% of subwatershed**	**Acres**	**% of subwatershed**	**Acres**	**% of subwatershed**
Berry Creek	3,077	53.3%	2,444	42.3%	94	1.6%
Canyon City	278	45.8%	243	40.0%	74	12.3%
Canyon Meadows	4,099	47.3%	3,745	43.3%	712	8.2%
Fawn	3,182	29.0%	6,024	55.0%	1,679	15.3%
Lower East Fork	3,584	48.7%	3,107	42.2%	399	5.4%
Middle Fork Canyon Creek	4,411	62.3%	2,482	35.1%	67	0.9%
Sugarloaf	1,639	23.7%	3,597	52.1%	1,650	23.9%
Upper East Fork	5,944	73.7%	1,589	19.7%	440	5.5%
Vance Creek	989	23.7%	2,537	60.9%	545	13.1%
Total acres for each condition class	**27,203**		**25,767**		**5,661**	

In addition to Fawn and Sugarloaf, Vance Creek had a large proportion of stands within live-fuels conditions 2 and 3 (Table 3.56). In general, stands within Vance Creek were decadent due to insects and severe infections of dwarf mistletoe; particularly in Douglas-fir dominated stands (Spiegel and Schmitt, 2002). The degree of dead fuels accumulation in these stands is not known but is expected to be very high due to damage from insects and disease. Vance Creek had a considerable land area in YFMS stage (1,644 acres, or 39% of the subwatershed) and 919 acres within the stem exclusion phase (805 acres in SEOC and 114 acres in the SECC stage). In general, these stands are typified by a dense understory that would not be common had fire returned at an interval of 35 to 50 years (fire regimes I and III). The continuity of condition 2 stands intermixed with conditions 3 stands implicate Vance Creek as an area of concern for uncharacteristic fire severity (*see Chapter 5-6*).

3.2.5.2 Wildland/Urban Interface

Approximately two-thirds of the acreage within the WUI was evaluated to have live fuels conditions that were outside their historic range, suggesting fire regimes have been moderately to considerably altered from their historic conditions. A total of 4,563 acres (13% of the WUI) were considered to have a live fuels condition class 3 (Map 3.16, Table 3.57). These values may appear low, considering fire exclusion has been in effect for ~10 fire cycles. However, at the scale of the WUI, the high proportion of condition 2 stands intermixed with condition 3 stands suggest a landscape-level condition that is dramatically altered from historic conditions. In addition, the results suggest the horizontal continuity of fuels is high for stands within the WUI on NFS lands within the watershed. Although quantitative data are not available, aerial photographs indicate conditions on non-federal industrial timberlands in the watershed appear similar if not more severe than neighboring NFS lands. The generally overstocked conditions on federal and non-federal lands underscore the importance of understanding the horizontal continuity of fuels, regardless of designation.

Table 3.57. Condition classes of vegetation stands within 59,578-acre analysis area.

	Condition 1		***Condition 2***		***Condition 3***		***All Conditions***
Area of interest	***Acres***	***% Area***	***Acres***	***% Area***	***Acres***	***% Area***	***Total Acres***
NFS lands within the Wildland/Urban Interface (WUI)	11,785	34%	17,721	51%	4,563	13%	34,460
NFS lands outside WUI	15,418	61%	8,046	32%	1,098	4%	25,118
Entire analysis area	**27,203**	**46%**	**25,767**	**43%**	**5,661**	**10%**	**59,578**

Outside of the WUI but within analysis area, approximately two-thirds of the acreage was found to have vegetation structure that suggests it to be functioning within the expected historic fire regimes (Table 3.58). The discrepancy between WUI and non-WUI stand conditions is largely due to the differences in vegetation types between the two areas and the fire regimes they have historically supported. In the upper elevations outside the WUI, rock outcrops intermixed with subalpine fir/ grand fir community types (Cold Upland Forests) harbor long return-interval fire regimes (ca. 200 years, or Fire Regimes IV-V). Because of their long fire return-intervals, it is difficult to ascertain the degrees of divergence as forest structure data do not predate the 1900s.

Dry Upland Forest types within the warm-dry plant associations (i.e., ponderosa pine, Douglas-fir, and warm grand fir types) are the forest stands of the most concern within the WUI (Table 3.58 and Table 3.59). In general, these forest stands had dense understory structures (i.e., YFMS or SEOC), which suggest a condition beyond those expected under natural fire regimes. In general, condition 2 and condition 3 stands were continuous across the landscape within the WUI, particularly in Vance Creek, the northern section of Fawn, and the southern section of Sugarloaf. Further discussion and recommendations are presented in later chapters.

Table 3.58. Number of acres and proportion of 34,460-acre Wildland/Urban Interface (WUI) on NFS lands within each Potential Vegetation Group (PVG) and plant association group (PAG) within each of three live-fuels condition classes.

		Condition 1		Condition 2		Condition 3	
Potential Vegetation Group	**PAG**	**Acres**	**% of WUI**	**Acres**	**% of WUI**	**Acres**	**% of WUI**
Cold Upland Forest	Cold Dry	136	0.4%	1	0.0%		
Cold Upland Forest	Cool Dry	6	0.0%				
Moist Upland Forest	Cool Moist	998	2.9%	414	1.2%		
Dry Upland Forest	Hot Dry	1,101	3.2%	2,956	8.6%	1,149	3.3%
Dry Upland Forest	Warm Dry	6,669	19.4%	12,963	37.6%	2,677	7.8%
Moist Woodland	Hot Moist	87	0.3%	17	0.0%		
Dry Woodland	Hot Dry	156	0.5%	6	0.0%		
Cold Upland Shrubland		127	0.4%				
Moist Upland Shrubland		956	2.8%	953	2.8%	474	1.4%
Dry Upland Shrubland		533	1.5%				
Moist Upland Herbland				7	0.0%	226	0.7%
Dry Upland Herbland		31	0.1%			37	0.1%
Moderate SM Riparian Forest	Warm Moderate SM	1	0.0%				
Low SM Riparian Forest	Cold Low SM	14	0.0%	44	0.1%		
Low SM Riparian Forest	Warm Low SM	708	2.1%	361	1.0%		
Low SM Riparian Shrubland		43	0.1%				
Moderate SM Riparian Shrubland		54	0.2%				
Non Vegetated Land		166	0.5%				
Total acres (% of WUI)		**11,785**	**34.2%**	**17,721**	**51.4%**	**4,563**	**13.2%**

A total of 391 acres could not be evaluated because they were grasslands or administrative lands.

Table 3.59. Number of acres and proportion of 34,460-acre Wildland/Urban Interface (WUI) on NFS lands within each structural class within each of three live-fuels condition classes.

		Condition 1		Condition 2		Condition 3	
Structural Class	**Description**	**Acres**	**% of WUI**	**Acres**	**% of WUI**	**Acres**	**% of WUI**
OFMS	Old Forest Multi Strata	3,037	8.8%	2,488	7.2%	766	2.2%
OFSS	Old Forest Single Stratum	77	0.2%				
SECC	Stem Exclusion Closed Canopy			1,442	4.2%	910	2.6%
SEOC	Stem Exclusion Open Canopy	5,543	16.1%	5,498	16.0%	679	2.0%
SI	Stand Initiation	26	0.1%	145	0.4%	75	0.2%
UR	Understory Regeneration			12	0.0%	13	0.0%
YFMS	Young Forest Multi Strata	344	1.0%	7,153	20.8%	1,382	4.0%
WOMS	Woodland Old Multi Strata	136	0.4%	17	0.0%		
WSE	Woodland Stem Exclusion	107	0.3%	6	0.0%		
BG	Bare Ground	607	1.8%				
NF	Non-Forested Land	1,909	5.5%	959	2.8%	738	2.1%
	Total Acres (% of WUI)	**11,785**	**34%**	**17,721**	**51%**	**4,563**	**13%**

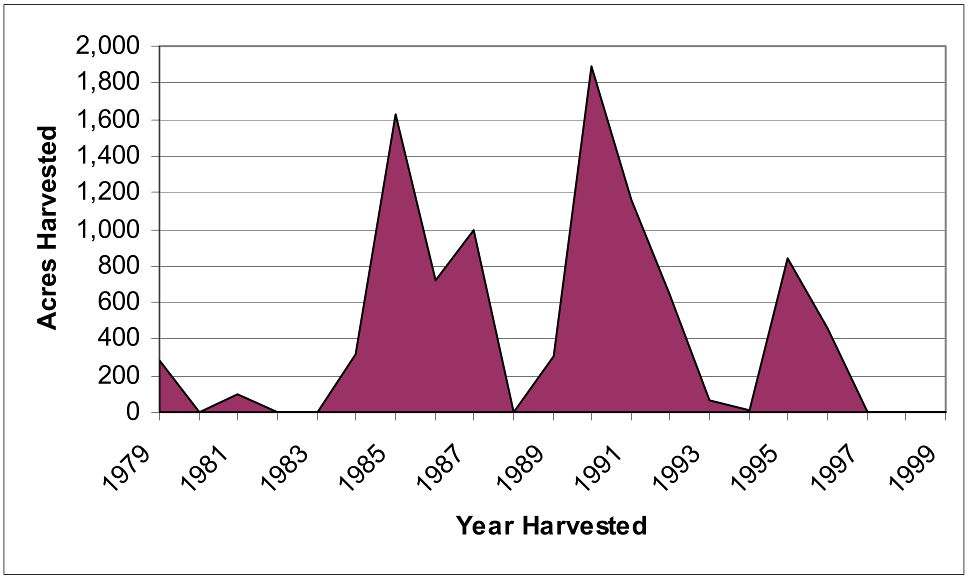
A total of 391 acres could not evaluated because they were grasslands or administrative lands.

3.2.6 Other Factors Affecting Ecosystem Function

3.2.6.1 Timber Harvest

Numerous silvicultural practices have been prescribed in the Canyon Creek watershed. The prescription goals have included commodity production, insect and disease control, and hazardous fuels management. Most prescriptions fit into the broad categories of selective harvest, shelter-wood harvest, thinning, seed-tree cuts, and clear-cutting. The area outside the Strawberry Mountain Wilderness has a high road density indicating that many stands have received silviculture treatments at least once. Ground-based skidding, and cable yarding on steep slopes are common methods used to get harvested wood out of the forest.

The most common silvicultural method employed throughout the watershed has been selective harvest, where mature timber is removed either as individual trees or in small clusters creating an uneven-aged stand. Generally, selective harvests have lead to the removal of large-diameter trees and have a forest structure dominated by a dense layer of smaller diameter trees (overstocking). This harvest method tends to leave trees vulnerable to disease, insect attack, and parasites (especially mistletoe). The combined effects promote live- and dead-fuels conditions that allow for crown fires that are uncharacteristic for the historic fire regimes (usually fire regimes I and III).



(source: USFS Metadata)

Figure 3.11. Frequency of timber harvest on Forest Service land within Canyon Creek watershed.

Data from 1979 through 1999 indicate timber harvest frequencies have been highly variable (Figure 3.11). Since 1979, a total of 9,417 acres were harvested within the analysis area using 11 different harvest methods (Table 3.60). In the southern portion of the watershed, both shelter-wood and seed-tree harvest methods have been used in moderation. Ponderosa pine and Douglas-fir are the primary "leave-tree" species in shelter-wood harvests for use as a partial shelter for seedling establishment and in seed-tree harvest as a seed source. These applications generally reduce the risk of disease, insect attack, and fire hazard. However, both methods reduce the tree crown canopy cover and expose soil to direct contact by rain, which in turn increases the potential for soil erosion and may alter the microclimate conditions of the understory needed for successful seedling establishment.

Clear-cutting involves the removal of all merchantable timber and then replanting to create new, even-aged stands. It has been primarily employed in the western portion of the Canyon Creek watershed as a sanitation-salvage technique on north slopes infected by mistletoe and insects (Spiegel and Schmitt 2002). The intent of the sanitation salvage is the removal of all trees to rid the stand of insects and disease, after which time new seedlings are planted. In practice, however, the trees left between the sanitation-salvage harvest units remain infected with disease and insects. These remnant trees are vectors for disease in the newly regenerating trees in old salvage units.

Table 3.60. Harvest methods used on NFS lands within Canyon Creek watershed from 1979 to 1999.

Activity	Description	Acres harvested
HCC	Clearcut	1,150
HCR	Clearcut with seed trees reserved	234
HFR	Final removal cut	1,545
HOR	Overstory removal cut	1,642
HPR	Partial removal cut	2,499
HSA	Sanitation (intermediate) cut	215
HSH	Shelterwood seed cut	538
HSL	Selection cut	189
HSP	Special uses cut	612
HSV	Salvage (intermediate) cut	314
HTH	Commercial (intermediate) thinning	477
	Total Harvest	**9,417**

Source: USFS harvest data

Pre-commercial and commercial thinning occur throughout the watershed. On south-facing slopes dominated by ponderosa pine, commercial thins have resulted in widely spaced second growth stands that resist insects and disease. Thinning can be an effective tool in restoring these south-facing ponderosa pine stands to their historic fire regimes.

3.2.6.2 Insects and Disease

Timber harvest, overstocking, and the removal of fire in fire-dependent communities have resulted in environments where pathogens (insects and diseases) have played a major role in defining forest structure and health. Understory densities of late seral species (Douglas-fir and grand fir) increased with timber harvest practices, and the absence of understory burning favored their establishment. The net result in many of these stands was a shift from single-stratum structure of ponderosa pine to a multi-strata structure of late seral species. The change in forest structure and species composition provided ideal feeding ladders for budworm larvae to infect all strata within the stand (Powell 1994).

Because of their life cycle and dependence on shade and mesic microclimates, the overstocking of late-seral species in understory strata makes forest stands more subject to climatic variation, especially drought stress. Drought conditions and growth stagnation from competition weakens the late-seral species and results in a stand that is more susceptible to insect and disease attacks. At the landscape-scale, these shifts in composition and structure have promoted an increase in favorable conditions for insect and disease outbreaks, and the continuity of stands that are susceptible for attack is high across the landscape. On balance, insects and disease have shifted from creating a localized disturbance to landscape-level, catastrophic outbreaks. This shift in the ecological role of pathogens from a "secondary" disturbance factor to a "primary" disturbance mechanism in the Blue Mountains is arguably a symptom of removal of keystone disturbances (fire), exacerbated by timber harvest practices that favor overstocked conditions (Powell 1994).

Two major outbreaks of western spruce budworm (*Choristoneura occidentalis*) occurred on the Malheur National Forest in the past century. The first occurred between 1944 and 1958, and culminated in ~460,000 acres affected by defoliation. The second outbreak was more recent and severe: a sharp increase in budworm affected ~1.3 million acres between 1980 and 1991, with a major peak in 1986. The Canyon Creek watershed was not immune to these outbreaks. Although not specific to the Canyon Creek watershed, the Malheur National Forest lands reviewed (Powell 1994) found an increase in tree mortality from 6% to 21% between 1980 and 1989 due to spruce budworm. Recently, Spiegel and Schmitt (2002) outlined the serious insect and disease problems in areas of the Canyon Creek watershed. These areas were: northerly aspects dominated by Douglas-fir and grand fir, southerly aspects dominated by ponderosa pine, Canyon Meadows Campground and Buckhorn Meadow Trailhead, Designated Old Growth areas, Crazy Creek, and Table Mountain.

3.2.6.2.1 Northerly Aspects

In the Douglas-fir dominated stands on north slopes, dense multi-layered canopies have undergone mortality from western spruce budworm and Douglas-fir beetle (*Dendroctonus pseudotsugae*). These conditions have increased the susceptibility to budworm, Douglas-fir engraver (*Scolytus unispinosus*) and pole beetle (*Pseudohylesinus nebulosis*). Moderate to severe dwarf mistletoe infestations in combination with severe insect damage have led to dead fuels conditions that would promote crown fires. Commercial thinning has been attempted in heavily infected stands with dwarf mistletoe (e.g., Vance Creek), resulting in rapid enlargement and proliferation of mistletoe brooms, declines in growth rates, and high incidence of mortality. Following thinning, the mistletoe has responded to increased light on understory firs, compounding mortality and fuels loading.

In ponderosa pine stands where understory-stocking levels are high with Douglas-fir and grand fir (condition 2 and 3 stands), mortality from western pine beetle (*Dendroctonus brevicomis*) in the large pines has increased with increasing understory basal area. It has been suggested that many of these stands are good candidates for commercial thins to reduce understory biomass and promote pine and larch dominance (Spiegel and Schmitt 2002). Heavy fuel loading is also common in these stands from insect damage and thinning.

3.2.6.2.2 Southerly Aspects

Many of the lower elevation ponderosa pine stands (i.e. those found in the WUI) on the north side of Canyon Creek watershed are second-growth communities. As identified in earlier sections of this chapter, these stands are in a stem-exclusion phase and are overstocked. Dwarf mistletoe and bark beetles are the two pathogens currently affecting these stands; both of which contribute to fuels loading and an increased probability of lethal crown fires. Use of controlled burn prescriptions in conjunction with thinning can promote OFSS stand structure. However, the loading of fuels (both live and dead) is a concern in these forest types.

3.2.6.2.3 North Aspect Grand Fir Communities

Many of the cooler grand fir stands may have been dominated by ponderosa pine in the past. Ponderosa pine was selectively removed from many sites, sometimes more than once. With increased densities of shade-tolerant species, larch dwarf mistletoe (*Arceuthobium laricis*) outbreaks have dramatically altered the population structure; high levels of larch mortality due to mistletoe have removed larch as a notable component of these systems. It is probable insects and disease have extirpated many of the seral species and, barring large disturbance events, dominance is unlikely to shift back toward ponderosa pine and western larch.

3.2.6.2.4 Other Areas

In the Canyon Meadows Campground and Buckhorn Meadows Trailhead areas, there are well-established understories of grand fir with only minor components of large-diameter ponderosa pine trees. Insect, fungus, and disease responses to aforestation are prevalent. Indian paint fungus (*Echinodontium tinctorium*) decay is present in grand fir, as are several root diseases (e.g., annosus root disease—*Heterobasidion annosum*). The main concerns in this area are the hazard trees generated by disease.

Crazy Creek contains mixed conifer stands, with mature western larch, ponderosa pine and Douglas-fir in the overstory and Douglas-fir, lodgepole pine and grand fir dominating the understory. Lodgepole pine mortality associated with the mountain pine beetle outbreak in the 1970s has created heavy ground fuels loading. The overstory larch and Douglas-fir is infected with dwarf mistletoe. Low to moderate levels of bark beetles and budworm damage is present.

Table Mountain contains well-spaced second growth ponderosa pine at low to medium risk for mountain pine beetle. Ground fuels from past timber harvest are considered to be high. In these multi-strata stands, the dense stocking of ~12” grand fir (180 ft^2/ acre BA) in combination with dwarf mistletoe in Douglas-fir could promote crown fires.

3.3 TERRESTRIAL SPECIES AND HABITAT

The Canyon Creek Watershed currently supports a wide range of wildlife habitat and species. A selected group of species was focused on for this analysis. The species were selected for one of the following reasons: it has federal threatened, endangered, proposed or sensitive status; it is a Malheur National Forest MIS; or it is an LRMP Featured Species or species of interest. MIS are identified to indicate effects of management activities on other species or major biological communities.

As stated in *Chapter 1*, the watershed contains a variety of vegetative types and successional stages that have been altered from historic conditions by both human and natural processes. Currently, 17 percent of the watershed is considered to be mature coniferous forest that may be late successional habitat. The wilderness provides high elevation alpine vegetation. Unique habitats, identified in the LRMP, include meadows, rimrock, talus slopes, cliffs, animal dens, wallows, bogs seeps and springs, and quaking aspens stands (USFS 1990). These areas would provide habitat for a variety of wildlife species in the watershed but the quantity and quality of this habitat was not available for this analysis. Habitat conditions for each proposed, endangered, threatened, and sensitive species MIS, featured species and species of interest are discussed below by grouping the species that are most likely to occur in similar vegetation types.

3.3.1 Proposed, Endangered, Threatened and Sensitive Species

3.3.1.1 Shrubland and Herbland Associated Species

3.3.1.1.1 Pygmy rabbit

This species is associated with habitats dominated with big sagebrush on deep, friable soils. Habitat suitability is related to the availability of forage (primarily big sagebrush), security from predation, and ease of burrow construction. Shrub cover and height are much greater in occupied verses unoccupied sites (Verts and Carraway 1998). There are no historic occurrences of this species documented in Grant County (Csuti et al. 1997). There are over 2500 acres of big sagebrush dominated shrublands within the watershed most of which occurring in the Fawn subwatershed It is unknown if these shrublands provide the suitable soils required by this species. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.1.2 Western sage grouse

Sage grouse are obligate residents of the sagebrush ecosystem, usually inhabit sagebrush-grassland or juniper-sagebrush-grassland communities. Sagebrush is a crucial component of the diet of this species year-round, and they select sagebrush almost exclusively for cover. Courtship display areas usually occur in open areas such as swales, irrigated fields, meadows, and roadsides, and areas with low, sparse sagebrush cover. Sage grouse prefer relatively tall sagebrush with an open canopy for nesting. This species has declined primarily because of loss of habitat due to the conversion of sagebrush habitat to grassland (Howard and Bushey 1996-98). 65% of the total acres of big sagebrush shrublands are distributed within the Fawn subwatershed but is unknown if this sagebrush habitat provides the suitable habitat conditions for sage grouse. Habitat conditions on private lands are unknown. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.1.3 Upland sandpiper

Upland sandpipers breeding habitat is restricted primarily to extensive, open tracts of short grassland habitat. They nest in native prairie, dry meadows, and pastures, and are also known to nest in dry patches of wet meadows (Carter et al. 1992). Preferred habitat includes large areas of short grass for feeding and courtship interspersed with tall grasses for nesting and brood cover (Carter et al. 1992). The estimated breeding population in Oregon is less than 100 birds, most of which breed in Logan and Bear Valleys (Csuti et al. 1997). There are no large open short grassland habitats within the Malheur National Forest. The private lands within the watershed are utilized for agriculture and are unlikely to provide habitat for this species. The dry meadow habitats within NFS lands are small, ranging from less than one acre to eight acres, and scattered and therefore unlikely to provide breeding habitat for this species. There are no documented occurrences in the watershed (USFS 2002c).

3.3.1.1.4 Gray flycatcher

This species is most abundant in extensive tracts of big sagebrush. It prefers relatively treeless areas with tall sagebrush, bitterbrush or mountain mahogany communities. This species can also occur in these communities within open forests of ponderosa or lodgepole fine or juniper woodlands with sagebrush understory (Csuti et al. 1997). This species territory has been reported to vary from three to nine acres with a home range of about 10 acres (Csuti et al. 1997). The mountain mahogany and sagebrush shrublands scattered throughout the watershed may provide habitat for this species. This species is not known to occur within the watershed (USFS 2002c).

3.3.1.1.5 Bobolink

Bobolinks are associated with open prairies, grasslands, wet meadows, and pastures. In Oregon, there are only a few disjunct populations that breed in wet, grassy meadows with local growths of forbs and sedges (Csuti et al. 1997). Small colonies are known to exist near Prairie City and John Day (Gilligan et al. 1994). Moist meadow habitat, which is preferred by this species, is very limited. This habitat is located in a four-acre and 27-acre meadow behind the dam in Canyon Meadow subwatershed and in a three-acre meadow in the Lower East fork subwatershed. The minimum grassland size utilized by this species is five to ten acres, but may be larger if the grasslands are fragmented (Jones and Vickery 1997). This species may use the meadow located behind the dam, but the suitability of this meadow as nesting habitat is unknown.

Due to the lack of suitable habitat, this species is not expected to occur in the watershed. The suitability of the pastures on private land to provide habitat for this species is unknown but this species is know to respond positively to properly timed burning, mowing and moderate grazing. There are no documented occurrences in the watershed (USFS 2002c).

3.3.1.2 Late and Old Structure Forest Associated Species

3.3.1.2.1 Bald eagle

The bald eagle is found along the shores of saltwater and freshwater lakes and rivers. Nests are usually located in mature or old growth trees that are the dominant or co-dominant tree in the overstory. Nest trees are usually live, but often have a dead or broken top with a limb structure to support the nest (Rodrick and Milner 1991). The nest tree usually has an unobstructed view of nearby water, and has stout upper branches that form flight windows large enough to accommodate the bird's large wingspan (Grubb 1976). Three main factors affecting distribution of nests and territories are proximity to water and availability of food; suitable trees for nesting, perching, and roosting; and the number of breeding-age eagles (Stalmaster et al. 1985). The old forest stands located along Canyon Creek may provide nest structures for bald eagles. However, forage is limited and bald eagles are unlikely to nest within the watershed. Several winter roosts are documented in Bear Valley, which is just south of the watershed. Peak winter use is from November to March (USFS 1999). Bald eagles have been sighted in the Fawn subwatershed near Highway 395 during the nesting season (USFS 2002c). However, no nests are known to occur in the watershed (Schuetz, pers. comm. 2002). Bald eagles have been observed during the winter in the Fawn, Lower East Fork and Vance subwatersheds.

3.3.1.2.2 Pacific fisher

In the interior Columbia basin, fishers occur primarily in the Cascade Range and Rocky Mountains (Witmer et al. 1998). The fisher inhabits dense coniferous and mixed coniferous/deciduous forests with extensive and relatively high, continuous canopy (Witmer et al. 1998). Old-growth or mature forests are generally preferred due to the increased availability of cover and den sites that these stands afford; however, second-growth forests with good cover are also used (Verts and Carraway 1998). Fishers occur at low to mid-elevations. Deep snow accumulation, such as typically occurs at higher elevations, appear to limit fisher movements and distribution. Riparian corridors are an important habitat that serves as travel corridors and provide productive habitat for fisher prey. In the lower elevations in Sugarloaf, Fawn and Lower East Fork subwatersheds, fishers may occur in the old-growth and mature forests. 17% of the watershed is in OFSS and OFMS structural stages with the majority of the stands occurring in the Sugerloaf subwatershed. OFSS and OFMS stands that are generally above 4,000 feet may limit fisher use of these areas due to deeper snow accumulations. The lower elevations within the watershed are in private ownership which would not provide suitable habitat for this species. There are no documented occurrences of fisher in the watershed (USFS 2002c).

3.3.1.3 Wide-ranging carnivores

3.3.1.3.1 Gray wolf

Gray wolves require a sufficient year-round prey base of ungulates and alternate prey, suitable and somewhat secluded denning and rendezvous sites, and sufficient space with minimal exposure to humans (USFWS 1987). Most wolf dens are in remote areas away from recreation trails and backcountry campsites. Dens are usually located on low-relief slopes with southerly aspects and well-drained soils, usually within close proximity to surface water and at an elevation overlooking surrounding low-lying areas (FWS 1987). Vegetation, elevation, climate, and other habitat variables are unimportant to the wolves as long as they have food and security. Forested cover provides security from human disturbance. Although minimal exposure to humans is not as important to wolf habitat as originally thought (USFWS 1993), it is a factor in maintaining high-quality big game habitat and reducing the risk of incidental wolf mortality. The Strawberry Wilderness could provide denning and rendezvous sites for wolves. Elk and mule deer occur in the watershed year-round and would provide a potential prey source for the wolves. Although the wolf is considered extirpated in Oregon, there have been several confirmed and many unconfirmed sightings with the Blue Mountains (Schuetz, pers.comm. 2002). Recent wolf sightings may be of wolves that originated from the experimental populations of wolves released into the Selway-Bitterroot and Frank Church River of No Return Wilderness areas of central Idaho. There are no known wolf sightings in the watershed (USFS 2002c).

3.3.1.3.2 Canada lynx

Historically, the Canada lynx (*Lynx canadensis*) ranged across most northern states in the contiguous United States, as well as throughout Alaska and much of Canada (Ruediger et al. 2000). The range of the lynx has been divided into geographical areas and subdivided into provinces and sections. The Malheur National Forest, Grant County, Oregon, is in the Northern Rocky Mountains Geographic Area, Middle Rocky Mountain Province, Blue Mountains Section (USFS 2003). This determined the direction in the Canada Lynx Conservation Assessment and Strategy (Ruediger et al. 2000) that was used to develop lynx analysis units (LAUs) and to assess the effects of USFS land management projects on lynx and their habitat.

The analysis area is within the Strawberry LAU, one of three LAUs on the Malheur National Forest. In the southern portion of their North American range, lynx are associated with boreal forests typically found in higher elevations of montane regions (Witmer et al. 1998). Lynx habitat includes subalpine fir, moist grand fir and moist Douglas-fir habitat types where lodgepole pine is a major seral component (Ruediger et al. 2000). A common component of natal denning habitat appears to be large woody debris, either down logs or root wads. Den sites may be located in regeneration stands older than 20 years or in mature conifer or mixed conifer-deciduous forest (Ruediger et al. 2000). Lynx require a mosaic of forest seral stages connected by forested stands suitable for travel cover; foraging habitat is usually near den sites. Home range sizes of lynx are quite variable but, generally, home range sizes at the southern extent of lynx range are larger than in northern boreal forest, due to lower prey densities and inherent habitat patchiness. Studies in Washington and Montana found home range size for males from 27 to 47 square miles and from 15 to 17 square miles for females. Large home range sizes indicate that lynx were required to travel extensively to locate sufficient prey resources (Ruediger et al. 2000). Lynx are highly dependent on snowshoe hares as prey, especially during the winter (Witmer et al. 1998). Snowshoe hares are associated with dense thickets of young conifers, especially firs and western larch with lower branches touching the ground, interspersed with small clearings vegetated by grasses and forbs (Verts and Carraway 1998). During the summer, snowshoe hares forage on a variety of forbs, grasses, and small shrubs. During the winter, food is limited to twigs and stems that are within reach above the snow surface. Lodgepole pine was found to be an important browse species for hares in Washington (Ruediger et al. 2000). Lynx at the southern periphery of the range may prey on wider diversity of species because of differences in small mammal communities and lower average hare densities as compared with northern habitats. Red squirrels have been shown to be an important alternative prey species, especially when the snowshoe hare population is low. Levels of grazing use, by livestock and/or wild ungulates, may increase competition for forage resources with lynx prey. By changing native plant communities such as aspen and high elevation riparian willow, grazing can degrade snowshoe hare habitat.

Lynx habitat occurs primarily in the cold/dry and cool/dry PAG's of the cold upland forest PVG, which is predominantly the lodgepole pine plant association. Currently, 25% of the LAU is classified as lynx habitat. The LAU extends well beyond the boundary of the watershed. All of the wilderness area within the watershed is included in the LAU but there is no opportunity to enhance habitat within a wilderness area. A portion of the LAU does extend into the general forest area of the watershed outside the wilderness area. The exact amount of acres in this area was not calculated for this analysis but management activities could be done at the project level to enhance habitat. Subalpine fir and Englemann spruce make up the remainder of the habitat (USFS 2003). The lodgepole pine plant association group is only dominant in 1% of the NFS lands in the watershed. There are no documented occurrences of lynx in the watershed (USFS 2002c). Lynx may use riparian corridors and ridges as travel corridors through the watershed. There have been 12 museum-documented occurrences of lynx in Oregon from 1897 to 1993, three of which were in the Blue Mountains. The occurrences in Oregon are likely from individuals that immigrate from occupied areas farther north and persist for a short time (Verts and Carraway 1998). ODFW confirmed that a lynx was trapped south of the Malheur National Forest boundary near Drewsey in 1995. The lynx was trapped in a juniper/sagebrush/shrubland/grassland habitat complex. Lynx surveys were conducted in the Strawberry LAU in 1999, 2000, 2001; no lynx were detected in these surveys (USFS 2003).

3.3.1.3.3 California wolverine

Wolverines are usually found in high elevation temperate coniferous forest, from mid-elevation (around 4,000 feet) to moderate high elevation (above timberline), depending on the season. Wolverines are found in subalpine dominated forests with medium to low canopy closure. They rarely use dense young timber, burned areas or wet meadows (Witmer et al. 1998). Wolverines use a variety of habitat features for dens, including exposed tree roots, rock piles, caves and log falls. Females were found to use subalpine talus sites for natal dens in Idaho (Witmer et al. 1998). Wolverines are believed to prefer secluded areas with minimal human disturbance. In northwestern Montana, average home-range areas were documented as 160 square miles for males and 150 square miles for females (Verts and Carraway 1998). Wolverines are known to occur in the Strawberry Mountain Wilderness. The most recent sighting was on Canyon Mountain in 1999 (USFS 2000c). Other sightings within the watershed include the carcass of a juvenile wolverine discovered in the wilderness along the Tamarack Trail in 1992 and an unconfirmed, although reliable, sighting of a wolverine in 1991 near Rattlesnake Ridge just outside the wilderness (USFS 2002c). The wilderness provides the best habitat for wolverines (including travel, forage, and denning), in the watershed. However, wolverines may use other areas in the watershed outside the wilderness.

3.3.1.4 Miscellaneous Habitat Associated Species

3.3.1.4.1 Bufflehead

Buffleheads nests near mountain lakes with permanent water surrounded by open woodlands containing snags. This species are usually cavity nesters and use abandoned woodpecker nests or natural holes. The preferred nest tree is aspen, but they will also nest in ponderosa pine or Douglas-fir. Buffleheads defend a territory around the brood, which results in t he spacing of family groups around the lakeshore. This species will use artificial nest boxes and it is thought most pairs nesting in Oregon use these boxes (Csuti et al. 1997). Buffleheads winter primarily along the coast and near Klamath Falls with smaller numbers wintering along major rivers (Csuti et al. 1997, Gilligan et al 1994). There is a lake located on private land, but the suitable nesting habitat conditions around this lake are unknown. Within NFS lands, the watershed does not provide suitable nesting as the Canyon creek reservoir does not sustain permanent water or wintering habitat for this species. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.4.2 Peregrine falcon

Peregrine falcons are limited to areas that contain suitable nest ledges. Cliffs and bluffs typically found along river courses and other large bodies of water usually provide habitat for nesting peregrines. Falcons prefer to nest where the concentration of prey, generally smaller birds, is high and where habitat characteristics may increase prey vulnerability. A 1992 survey identified cliffs on Canyon Mountain as having medium potential for reintroducing peregrine falcons. Additional cliffs may exist elsewhere in the watershed (Schuetz, pers. comm. 2002). There are no large bodies of water to provide high concentrations of prey for this species within the watershed. There are no known occurrences of this species in the watershed (USFS 2002c).

3.3.1.4.3 Tricolored blackbird

This species generally prefers to breed in freshwater marshes with emergent vegetation or in thickets of willows or other shrubs. In Oregon, this species has bred in tangles of Himalayan blackberry growing in and around wetlands. Tricolored blackbirds are often found breeding in the company of red-winged blackbirds (Csuti et al. 1997). The moist meadows and riparian habitat could provide suitable habitat for this species. The quality of the habitat for breeding is unknown. There are no confirmed occurrences of this species on the Malheur National Forest (Schuetz, pers. comm. 2002).

3.3.1.4.4 Columbia spotted frog

Spotted frogs are highly aquatic and are rarely found far from permanent water. Breeding habitat is usually in shallow water in ponds or other quiet waters along streams. Breeding may also occur in flooded areas adjacent to streams and ponds. Adults may disperse overland in the spring and summer after breeding. Habitat has most likely been degraded by past management activities, such as livestock grazing, road construction along streams, and timber harvest adjacent to streams, lakes ponds, springs, and marshes The spotted frog is considered present in all subbasins on the Malheur National Forest (USFS 2002c). It is assumed this species is widely distributed in the analysis area. No habitat surveys have been conducted specifically for spotted frogs; however, habitat probably exists along most perennial and some intermittent streams (USFS 2002c).

3.3.1.5 Management Indicator Species (MIS)

3.3.1.5.1 Elk

Elk are thought to be well distributed and abundant in the watershed. The watershed is in winter range and summer range, with 26% of the watershed in winter range and the remaining in summer range. Winter range is primarily below 5,200 feet in elevation (USFS 1990). Elk typically move below 5,500 feet during the winter depending on the snow levels. Elk and mule deer utilize the watershed throughout the year. The LRMP identifies three habitat types: satisfactory cover, marginal cover, and hiding cover. Satisfactory cover is defined as a stand of coniferous trees 40 or more feet tall with multi-strata structure, with or without large-diameter trees, that have a canopy closure of 50% or greater for ponderosa pine or 60% or greater for mixed conifer. Marginal cover is defined as a stand of coniferous trees ten or more feet tall with a canopy closure greater than 40% (USFS 1990). Marginal cover can occur in old forest or young forest with multi-strata structure and stem exclusion with closed canopy stand structures. Hiding cover is defined as vegetation capable of hiding 90% of a standing adult deer or elk from human view at 200 feet. Hiding cover can occur in multi-strata with and without large trees and in stem exclusion closed-canopy stand structures. The minimum forest standards for elk cover in winter range is 10% for satisfactory and 10% for marginal cover; in summer range, 12% for satisfactory and 5% for marginal cover. Total cover minimum in both winter and summer range is 25% (USFS 1990). Currently in winter range, satisfactory cover is 3% and marginal cover is 19% (Table 3-61 and Map 3.14). In summer range, satisfactory cover is 10% and marginal cover is 19%. The total cover in both winter and summer range is 52%. All cover data displayed in the following table is based photo-interpreted stand conditions. For site-specific project analysis, this data should be validated with ground surveys. For this reason, the Habitat Effectiveness Analysis (HEI) model (Thomas et. al. 1988) for estimating elk habitat effectiveness on a landscape level was not conducted for this analysis. The HEI model will need to be conducted at the project level analysis to comply with LRMP Forest-wide Standards 28-31.

Table 3.61. Elk winter and summer range cover.

Subwatershed	Winter range satisfactory cover	Winter range marginal cover	Summer range satisfactory cover	Summer range marginal cover
Canyon Meadows	1% (75 ac)	14% (1,178 ac)	10% (872 ac)	25% (2,169 ac)
Fawn	3% (366 ac)	36% (3,925 ac)	1% (140 ac)	9% (1,036 ac)
Middle Fork Canyon Creek	1% (49 ac)	3% (187 ac)	16% (1,145 ac)	23% (1,619 ac)
Sugarloaf	12% (854 ac)	34% (2,372 ac)	3% (196 ac)	5% (341 ac)
Upper East Fork	1% (113 ac)	3% (245 ac)	23% (1,877 ac)	33% (2,663 ac)
Lower East Fork	6% (458 ac)	13% (983 ac)	14% (1,045 ac)	28% (2,064 ac)
Berry Creek	2% (143 ac)	18% (1,064 ac)	14% (781 ac)	18% (1,058 ac)
Canyon City	1% (8 ac)	22% (131ac)	5% (32 ac)	27% (164 ac)
Vance Creek	1% (36 ac)	33% (1,391 ac)	0% (0 ac)	9% (378 ac)
Total	3% (2,104 ac)	19% (11,478 ac)	10% (6,089 ac)	19% (11,492 ac)

In the watershed, calving and fawning habitat is generally located near high-quality forage and ground based hiding cover on gentle slopes (less than 15%). Calving and fawning habitat has been identified in portions of Middle Fork Canyon Creek, Canyon Meadows and Vance Creek subwatersheds. The majority of the 1,036 acres of calving and fawning habitat identified is located in Vance Creek. The majority of the slopes in the watershed is greater than 15% and may not provide ideal habitat. The flatter terrain in the watershed can be found in Fawn and Lower East Fork subwatersheds. Calving and fawning habitat may occur along the lower gradient streams that have a more developed floodplain, which may provide quality forage and hiding cover. Current forage habitat is thought to be less abundant than historical levels. The higher canopy closures of the mixed conifer stands provide less forage compared to the open ponderosa pine stands. Lack of fire in the watershed may also have impacted forage levels as the absence of fire can lead to overstocked stands and reduce the availability of forage. In addition, the long-term heavy use by domestic livestock and elk has caused the moderate to severe reduction of shrubs and forage productivity in the watershed (Irwin et al. 1994).

High open road densities increase the potential to disturb elk, which could reduce the use of preferred habitats. Within the watershed all motorized vehicle use is restricted within winter range between December 1 and April 1 to minimize disturbance to big game and other wildlife. The wilderness is closed to all motor vehicles including power and mechanical equipment year-round. The forest standards for open road density are 2.2 miles per square mile in winter range and 3.2 miles per square mile in summer range. The open road density by subwatershed is shown in Table 3.62. The Middle Fork Canyon Creek is the only subwatershed that meets the forest standard for road density in winter range. Even when the wilderness is included in the open road density calculations in Canyon Meadows the forest standard for winter range is exceeded. The open road density standards for summer range are exceeded in Canyon Meadows, Middle Fork Canyon Creek and Vance Creek subwatersheds. Road closures that use sign, guardrails, or other methods that leave the road accessible to motorized vehicles may not be effective at reducing human disturbance behind these closure types. Obliterated roads are the most effective closure type to benefit wildlife.

In summary, satisfactory cover in winter range is lacking and below LRMP minimum standards in all subwatersheds except Sugarloaf. Marginal cover in winter range is mostly above forest standards except in Upper East Fork and Middle Fork Canyon Creek. Open road density (Table 3-62) exceeds LRMP standards in all subwatersheds except those that are totally within the wilderness. Winter range for elk in the watershed is therefore negatively impacted by a lack of satisfactory cover and a high open road density. The marginal cover in the winter range may mature into satisfactory cover over time but the condition of this cover has not been field verified to assess the rate of that maturity.

Elk summer range also has a lack suitable satisfactory cover in all subwatersheds except for those in the wilderness area however marginal cover exceeds LRMP standards in all subwatersheds. Open road densities are above minimum standards in most subwatersheds so as is the case in the winter range, elk in the watershed are negatively impacted by a lack of satisfactory cover and a high open road density.

Table 3.62. Elk Winter and Summer Range Open Road Density.

Subwatershed	Winter range open road density (miles/sq. mile)		Summer range open road density (miles/sq. mile)	
	Including wilderness	Excluding wilderness	Including wilderness	Excluding wilderness
Berry Creek	0	0	0.3	0.7
Byram Gulch	1.0	3.2	0	0
Canyon Meadows	2.6	3.7	0	5.9
Fawn	N/A	2.3	N/A	3.0
Lower East Fork	0	N/A	0.23	0.8
Middle Fork Canyon Creek	0.66	1.7	0	3.5
Sugarloaf	N/A	3.3	N/A	4.1
Upper East Fork	0	N/A	0	N/A
Vance Creek	N/A	6.3	N/A	3.8

3.3.1.6 Late and Old Forest Associated MIS

Late and old forest habitat is currently provided in both multi-strata and single-stratum stand structure. There are approximately 10,085 acres of old-forest multi-strata and 201 acres of single stratum or approximately 17 percent of the NFS lands within the watershed. The old forest multi-strata stands are primarily located in the Sugarloaf subwatershed but is well distributed in the Lower East Fork and portions of Fawn subwatersheds. These stands are dominated by ponderosa pine, Douglas-fir and warm grand fir warm-dry plant associations. The OFMS stands throughout the watershed appear to be well-connected to one another through stands in the SEOC, SECC and even YFMS stand structure classes. The condition of these stands would need to be field verified to assess their effectiveness but it can be assumed that these stand structures, which dominate over 71% of the analysis area, are providing dispersal and forage opportunities for species traveling between OFMS stands.

The LRMP identified Dedicated Old-Growth (DOG) and Replacement Old-growth (ROG) management areas to provide habitat for wildlife species dependent on mature and/or overmature forest conditions (see Map 3.17). These areas were designed to provide habitat for pileated woodpecker and/or pine marten. However, the current condition of the vegetation structures (i.e., snags and down wood) in these management areas are unknown and may not support old growth dependent species at this time. There are nine DOG management areas in the watershed, which total 3,675 acres and two ROG management areas, totaling 475 acres. The DOG and ROG areas incorporate approximately five percent of the watershed. They occur primarily within the Strawberry

Wilderness, with only two DOG and two ROG areas located outside the wilderness. These management areas occur in the mixture of dry upland forest and moist upland forest PVGs. The moist upland forest would provide more favorable habitat conditions for both pileated woodpeckers and pine martens. The moist upland forest are primarily located within the wilderness. The dry upland forests could provide habitat for these species where true fir species and large snags and down wood are present. The dry upland forests are typified by a combination of ponderosa pine, Douglas-fir, and warm grand fir plant associations. The DOG areas are primarily located in young multi-strata forest with areas in old-forest multi-strata and stem exclusion open canopy stand structures. As is the case with the OFMS stands the DOG's and ROG's are also well connected to one another by SECC, SEOC and YFMS stands discussed above. The watershed only contains 11% (6,530 acres) that are non forested or in the early stand initiation condition. It can be assumed that is ample cover for species to travel and forage between stands with more complex structure.

3.3.1.6.1 Pileated woodpecker and pine marten

Pileated woodpeckers are associated with old-growth ponderosa pine-mixed conifer forests, mature grand fir/mixed conifer, and mature ponderosa pine-dominated mixed conifer vegetation types, almost exclusively within the multi-strata stand structure. Large-diameter snags are an important habitat component for this species (Csuti et al. 1997). In the mixed conifer forests of eastern Oregon, pileated woodpeckers were found to nest in snags greater than 20 inches dbh. This species is associated with a snag density of 6.8 to 7.7 snags per acre (Bull 1997). Pileated woodpeckers have large home ranges that can vary from 500 acres to over 1,000 acres (USFS 1998). Pine martens prefer mature, mesic coniferous forest, with high structural diversity in the understory (Witmer et al. 1998). Pine martens have large home ranges, with the female home range varying from 24 to 445 acres and the male home range varying from 220 to 1,000 acres (Verts and Carraway 1998). Large diameter snags (greater than 21 inches) are an important habitat component for this species (Csuti et al. 1997). The old forest multi-stratum stands within the Sugarloaf, Fawn and Lower East Fork may provide habitat for both of these species. These areas are primarily in the dry upland forest. As stated above the moist upland forests located in the wilderness would provide more favorable habitat conditions. The availability of snags and down wood within these stands is unknown and therefore the distribution of these species is difficult to determine. Pileated woodpeckers are known to occur in the Fawn, Lower East Fork, Sugarloaf, and Vance subwatersheds (USFS 2002c). The only documented occurrence of pine marten is in the Vance Creek subwatershed in 1989 (USFS 2002c) but it can be assumed that pine marten also occurs in the Fawn, Lower East Fork, and Sugarloaf, subwatersheds due to the presence of suitable habitat.

3.3.1.6.2 Northern goshawk

The goshawk was not identified in the LRMP as an MIS species, but rather is listed in Amendment 2 of the LRMP as a species of interest and is known to use late and old forest habitats (USFS 1995). This species nests are primarily associated with mature and young, multi-storied ponderosa pine stands, or ponderosa pine-dominated mixed conifer stands in the watershed. Although these habitat types are not considered preferred nesting habitat, nests have been found in old-growth mixed conifer and true fire habitats. The old forest multi-strata stands are well distributed in the Sugarloaf, Fawn and Lower East Fork subwatersheds, Map 3.13).

There are four documented goshawk nesting territories located in the watershed and a portion of a nesting territory located in an adjacent watershed. Amendment 2 of the LRMP (USFS 1995) states that 30 acres of suitable nesting habitat should be established around occupied and historical nest sites that have been occupied at some time during the past five years. In addition to the nesting habitat a 400-acre post fledgling area should be established around active nest sites. There are two territories within the Vance subwatershed, Vance and Starr Camp. The Vance territory was first documented in 1987 and was last documented as successfully fledging young in 1995 (USFS 2002c, USFS 2003a). This territory has been unoccupied since 1996 (USFS 2003a). The nests in this territory have been located in ponderosa pine and dense fir young multi-strata stands. The post-fledging area consists of young multi-strata, stem exclusion open canopy and old forest multi-strata stands in dry upland forest. The Starr Camp nest is located in the adjacent watershed with a portion of the post fledgling area located in this watershed. This nesting territory has been occupied since 1993 and successfully fledged young for nine years (USFS 2003a). The post-fledging area within the watershed is primarily old forest multi-strata and young multi-strata dry upland forest. The Fawn nest territory was first established in 1994. This territory is located in old forest multi-strata ponderosa pine stand. The post-fledging area is dominated by young and old multi-strata forests. Of the nine years this territory has been surveyed it has successfully fledged young four times (USFS 2003a). The Big Canyon territory is located in Canyon Meadows subwatershed. A portion of the post-fledging area is located in an adjacent watershed. This territory was last documented as active in 1999 and was successfully fledged young three times since 1994 (USFS 2003a). The nests were found in an old forest multi-strata stand that is surrounded by stem exclusion open canopy upland dry forest. The Table Mountain territory successfully fledged young in 1992 but has been unoccupied since that time. A post-fledging area has not been established for this territory.

3.3.1.6.3 Three-toed woodpecker

Three-toed woodpeckers are associated with higher elevation (above 4,500 feet) lodgepole pine and mixed conifer forests with a lodgepole pine component. This species uses mostly pole-sized trees for nesting and foraging and prefers areas with a higher snag density (Csuti et al. 1997). Lodgepole pine is a minor component of the grand fir vegetation type as a seral species. This species preferred habitat is in the cool moist upland forest in old forest multi-strata stand structure or multi-strata lodgepole pine stands. The moist upland forest occupies approximately 10,800 acres or 21 percent of the watershed and is located primarily in Berry, Upper and Lower East Fork subwatersheds.

However, the majority of this area is in young multi-strata stand structure. Lodgepole pine dominated stands are scattered across the watershed in the moist and cold upland forest in Berry, Upper and Lower East Fork, Canyon Meadows and Middle Fork Canyon Creek subwatersheds. These stands are all young forest in either multi-strata or stem exclusion stand structure. These stands may provide suitable habitat for this species. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.6.4 White-headed woodpecker

This species is closely associated with ponderosa pine forest or mixed conifer forest dominated by ponderosa pine. This woodpecker prefers open stands with 50 % or less canopy closure (Marshall 1997). Nesting habitat is associated with large-diameter ponderosa pine with moderate to extensive decay and with broken tops (Dixon 1995). Amendment 2 of the LRMP (USFS 1995) identified the white-headed woodpecker as a species known to be associated with late and old forest habitats. This species is associated with large diameter snags (greater than 21 inches) at a snag density of 1.6 snags per acre (Dixon 1995). Studies in Oregon show abundance of this species is positively associated with increasing abundance of large-diameter ponderosa pines (Marshall 1997). Suitable habitat was historically found in the old-forest single-stratum ponderosa pine found in the dry upland forests within the watershed. Currently this OFSS habitat is virtually non-existent within the watershed. This small, fragmented patch of suitable habitat is unlikely to support nesting white-headed woodpeckers in the watershed as the home range size has been documented at 250-500 acres (Csuti et al. 1997). This species was observed in the Fawn subwatershed near Canyon Creek in 1992 (USFS 2002c).

3.3.1.7 Deadwood Associated MIS

A majority of wildlife species relies on moderate to high levels of snags and down wood during some stage of their life cycle for nesting, roosting, denning and/or feeding. Large-diameter snags and down wood are important components of late and old structural forest. Amendment 2 of the LRMP states that all timber sale activities will maintain snags and green tree replacement trees greater than 21 inches dbh, when available, to meet 100 % of the potential population of primary cavity excavators. To meet the interim wildlife standard of 100 % population levels, 2.4 snags per acre are needed (USFS 1995). Large-diameter snags and green replacement trees have been greatly reduced by past management practices, which make meeting this standard difficult in the watershed. Smaller diameter snags may be present in the dry upland forests due to high stocking density cause by mortality. Insects and disease may also create patches of small or large diameter snags within the watershed. Severe insect infestations and damaged have been documented within the forested uplands within the watershed. The current snag and down wood density and distribution within the watershed is unknown and cannot be derived from the PI data. Discussions with FS staff indicated that, in general, large snags (over 21 inches DBH) are lacking in harvest units and dry forest types as past harvest practices and overstocking has resulted in younger structural stages. Small diameter snags may prevalent in these stands due to insect and disease outbreaks. The Strawberry Mountain wilderness area most likely has higher levels of snags in all size classes. It can be expected that large diameter snags persist due to a lack of past timber harvests and it can also be expected that small diameter snags persist from several fires and insects and disease. Similarly down wood levels are above LRMP standards except in prescribed units. Overstocking within the WUI has also resulted in high level of small diameter down wood creating a fire hazard of finer fuels. Down woody levels are also thought to be high in the wilderness for the same reason as stated above for snag levels.

3.3.1.7.1 Lewis' woodpecker

Lewis' woodpecker is associated with open forest and nests in open oak or oak-conifer woodlands, cottonwood, and logged or burned ponderosa pine forests. It usually nests in large snags in cavities created by other woodpeckers or in very soft snags. Since this species is an aerial feeder it needs open areas for foraging. Lewis' woodpecker also forages on the ground and in brush. This species utilizes burned areas after the brush layer has developed and nesting cavities are available (Knotts 1998). The recently burned area in the wilderness may provide habitat for this species after the brush layer has developed. Open and deciduous habitat preferred by this species is lacking in the watershed. Large-diameter and very soft snag habitat may occur in the wilderness. There are no documented occurrences of this species in the watershed (USFS 2002c).

3.3.1.7.2 Black-backed woodpecker

Black-backed woodpeckers are attracted to forests that contain large numbers of wood-boring larvae, its primary food source. This habitat type, with dead, insect-infested trees, is usually found in areas associated with large-scale disturbances such as fire or windthrow, or in mature or old growth stands. This species prefers to nest in smaller (average 12-inch dbh) recently dead trees in areas that contain the highest density of snags. Black-backed woodpeckers have been found to be relatively restricted in distribution to early post-fire conditions. Conditions in burned areas usually become less suitable for this species five to six years after a fire (Knotts 1998). The recent High Roberts Fire in 2002 adjacent to the watershed and several recent smaller-scale fire in the wilderness near Indian Creek Butte that may provide suitable habitat for this species. Potential habitat may also occur in the old multi-strata forest in the dry upland forests within Sugarloaf, Lower East Fork and portions of Fawn subwatersheds. The high insect-infested habitat component preferred by this species may be lacking in this potential habitat. The introduction of fire suppression has reduced the occurrence of suitable habitat conditions preferred by this species in the watershed. The only documented occurrence of the black-backed woodpecker in the watershed is a pair using a burned ponderosa pine area in the Canyon Creek subwatershed in 2000 (USFS 2002c).

3.3.1.7.3 Williamson's sapsucker

Williamson's sapsucker uses mature higher-elevation coniferous forest for nesting and feeding. Open ponderosa pine forest is the preferred habitat but this species may use lodgepole pine, grand fir, Douglas-fir and aspen (Csuti et al 1997). This species nests in large (greater than 20-inch dbh) trees that are live or dead (Knotts 1998). Large-diameter snags are generally lacking within the watershed due to previous logging practices. The old multi-strata forest in Sugarloaf, Lower East fork and Fawn may provide habitat for this species. Suitable habitat may also occur in the old forest stands within the wilderness where management activities may not of limited large-diameter snags. This species was documented in the Sugarloaf subwatershed in 1993 (USFS 2002c).

3.3.1.7.4 Downy woodpecker and red-naped sapsucker

The downy woodpecker and red-naped sapsucker are associated with riparian habitats but will use coniferous habitats. The downy woodpecker is mostly found in cottonwood and aspen and prefers soft, smaller (10- to 12- inch dbh) snags for nesting (Knotts 1998). The red-naped sapsucker prefers to nest in aspen but will use ponderosa pine (Csuti et al. 1997). There are small fragmented stands where aspen is the dominate species in Canyon Meadows and Middle Fork Canyon Creek that provide approximately one acre of habitat. Aspen is component of some of the coniferous stands within the watershed. Overall deciduous forests are generally lacking within the watershed. The downy woodpecker is known to occur in the Canyon Creek subwatershed and there is no known occurrence of red-naped sapsucker in the watershed. Hairy woodpecker and northern flicker

Both the hairy woodpecker and northern flicker use a variety of habitats but tend to prefer open habitats. The hairy woodpecker nest in snags with a minimum dbh of 10 inches (Thomas 1979). The northern flicker nests in large, well-decayed snags, but may dig a hole in a dirt embankment, especially in eastern Oregon (Csuti et al 1997). Both species forage on the ground but the hairy woodpecker spends more time foraging on tree trunks. They will also use burned areas but are not dependent on them (Knotts 1998). Open forest habitat is limited, but since both species use a variety of habitats they may be well distributed within the watershed. The hairy woodpecker has been observed in a burned area in the Canyon Creek subwatershed and both species have been seen in the Fawn and Sugarloaf subwatersheds (USFS 2002c).

3.3.1.8 LRMP Featured Species

The LRMP identifies the following six species, for which management activities will be conducted to promote and enhance habitat: osprey, bighorn sheep, upland sandpipers, sage grouse, blue grouse, and pronghorn (USFS 1990). These species occupy a variety of stand structures and biophysical environments. Upland sandpipers and sage grouse are discussed above in the Proposed, Threatened, Endangered and Sensitive Species section of this chapter. The LRMP also discusses protecting active raptor nests. Known raptor use of the watershed is discussed below.

3.3.1.8.1 Osprey

Osprey require large, dead trees suitable for nesting adjacent to or near large rivers or lakes. Most of the ospreys diet consists of fish but will prey on birds, reptiles and small mammals (Csuti et al. 1997). This species has adapted to artificial nesting structures. The LRMP states that large snags and green replacement trees suitable for nesting should be maintained and created 0.5 miles from streams, lakes and reservoirs that are currently being used by osprey. Preference should be given to large trees (30 inches or greater dbh and 60 foot minimum height) that have broken tops of large branches (USFS 1990). Generally, these snags should be located in areas of solitude. In Oregon, this species is considered abundant and well distributed in areas with large water bodies. In the watershed, there is one known nest located in the Canyon Meadows watershed. This nest was first located in 1990 and successfully fledged young in 2002 (USFS 2003b). The only other sighting in the watershed was in 1994. An osprey was observed foraging in Canyon Creek in the Fawn subwatershed. The watershed does not have a high density of large, fish bearing water bodies, so this species is not expected to be abundant in the watershed.

3.3.1.8.2 California bighorn sheep

Bighorn sheep primary habitat is open areas on rocky slopes, ridges, rimrocks, cliffs, and canyon walls with adjacent grasslands or meadows but few trees (Verts and Carraway 1998). Habitat for this species is located in the wilderness and was last observed in 1998 (Schuetz, pers. comm. 2002). Twenty-one sheep were re-introduced on Canyon Mountain in 1971, but the population has remained static or decreased since the release. ODFW considers the re-introduction effort a failure since the population is not self-sustaining or expanding in population. ODFW believes the main reasons for the failure are limited satisfactory winter habitat, excessive predation of all age classes and that portions of the wilderness are too steep, leading to accidental falls (Schuetz, pers. comm. 2002). Habitat for bighorn sheep is unlikely to occur outside of the wilderness area in the watershed.

3.3.1.8.3 Blue Grouse

Blue grouse is found in coniferous stand dominated by Douglas-fir or true firs. Within those forests they seek out areas with thickets of deciduous species such as willow, alder, and aspen. In winter they move upslope to more open coniferous forest, and in spring they move to the lower edge of the forest, where there is cover of deciduous trees and shrubs (Csuti et al. 1997). The LRMP states that winter roost habitat should be maintained. Preferred habitat is clumps of mistletoe infected Douglas-fir tops or upper slopes of ridges (USFS 1990). Blue grouse winter roosting habitat was mapped by the FS in subwatersheds in which field verification of habitat has occurred. This field verification occurred in three subwatersheds (Vance Creek, Middle Fork Canyon Creek, and Crazy Creek). Douglas-fir dominated communities located on the northerly aspects were identified as having substantial areas of moderate and severe levels of dwarf mistletoe and can serve as suitable habitat. 355 acres of field verified winter roosting habitat is located in the Vance subwatershed with scattered patches of roosting habitat located in the Middle Fork Canyon Creek and Crazy Creek subwatersheds. Field verification has not occurred in the remaining subwatersheds however Douglas-fir dominated stands comprise 30% of the analysis area (18,095 acres) and it can expected that a majority of these acres are infected with mistletoe and providing habitat for blue grouse. This species has no federal or state status. Blue grouse have been documented in Sugarloaf and Vance subwatersheds (USFS 2002c). The current distribution and abundance of this species in the watershed is unknown.

3.3.1.8.4 Pronghorn

In Oregon, this species is associated with open grassland, sagebrush flats and shadscale-covered valleys of the central and southeastern part of the state. Low sagebrush (*Artemisia arbuscula*) is an important habitat component (Csuti et al. 1997). There are no open grassland or sagebrush flats (i.e., greater than 500 acres) within the NFS lands to support this species. The private lands within the watershed are primarily used for agriculture and are unlikely to provide habitat for this species. There are no documented occurrences of pronghorn in the watershed (USFS 2002c).

3.3.1.8.5 Neotropical migratory land birds

A wide variety of land birds, including neotropical migrant birds, use habitats available within the analysis area. Habitats include a mixture of conifer forest, hardwood habitats, riparian areas and meadow habitats. Nesting, foraging and cover security needs are generally provided. The abundance of conifer habitats, present in a variety of stand structures and vegetative compositions, provides suitable habitat for most of the conifer habitat dependent species. Those species heavily dependent upon riparian or hardwood habitats such as aspen, cottonwood or willow stands are not adequately provided for due to generally poor riparian habitat condition and distribution. Species such as the red-naped sapsucker (also MIS), hermit thrush, red-eyed vireo and olive-sided flycatcher are likely affected. Grassland/meadow habitats are also on the decline as conifers continue to encroach into previously non-forested areas.

A conservation plan for land birds has been drafted by Partners in Flight. According to this report, current vegetation in the Blue Mountains has changed substantially due to a number of factors associated with human occupation of the area. Coniferous forest still dominates the landscape, but the composition of forest types and conditions has changed from anthropogenic factors rather than the natural forces that used to maintain the landscape. These include fire suppression, intensive forest management, grazing, and widespread development of roads associated with development, recreation, and timber harvest (Hann et al. 1997). Associated consequences from these activities that impact the current landscape include exotic species invasion, alteration of natural disturbances, and fragmentation and isolation of habitat patches. Fragmentation resulting from timber harvesting can have several negative effects on landbirds such as insufficient patch size for area-dependent species, and increases in edges and adjacent hostile landscapes, which can result in reduced productivity through increased nest predation, nest parasitism, and reduced pairing success of males. Additionally, fragmentation has likely altered the dynamics of dispersal and immigration necessary for maintenance of some land bird populations at a regional scale.

3.3.1.8.6 Raptors

The LRMP provides direction to protect active raptor nests. The nest trees of active raptor nests and habitat immediately surrounding the nest should be protected from adverse impacts from management activities during the nesting season. Where possible, retain trees with inactive nests that maybe important to secondary nesters such as the great gray owl. For bald and golden eagles the LRMP refers to the Pacific Bald Eagle Recovery Plan for Protection of Bald and Golden Eagles for direction. All management activities that could alter site characteristics or disturb these birds will be suspended until the nest sites are evaluated by a wildlife biologist. Table 3.63 identifies the raptor species that are known to nest within the watershed or have been observed in the watershed.

Table 3.63. Raptor Locations in the Canyon Creek watershed.

Species	Subwatershed with occurrences	Comments
Golden eagle	Fawn and Vance	Primarily a winter visitor to watershed with only one observation during breeding season. Seven documented observations from 1992 to 1999.
Red-tailed hawk	Canyon Meadows, Fawn, Sugarloaf, and Vance	Documented nests located in Sugarloaf and Canyon Meadows. Nests were active in 1994 and 1998. Potential nest on private lands in 1993. This species is a common year-round resident in the watershed.
Cooper’s hawk	Fawn and Vance	Observations documented in summer of 1993 and 1994. May nest in watershed.
Prairie falcon	Middle Fork Canyon Creek and Vance	Nest located in Middle Fork Canyon Creek was active in 1992. Nest documented as gone in 1998. Single observation in Vance in August 1994.
Flammulated owl	Sugarloaf	No information is available for this nest.
Northern pygmy owl	Middle Fork Canyon Creek and Vance	Observations in 1994, 1995 and 2001. May nest in watershed.
Kestrel	Vance	Two birds observed in August 1994. May nest in watershed.

3.4 HUMAN USES

The current human uses in the Canyon Creek watershed include grazing, mining, recreation, and special uses, and involve issues of water and treaty rights. These activities and issues have influenced the patterns and opportunities of other human uses and environmental conditions in the watershed. The evaluation of current human uses provides insight into the cultural forces in the Canyon Creek watershed.

3.4.1 Grazing

For this analysis, no data were available that would describe the intensity and magnitude of livestock grazing within the Canyon Creek watershed. There are, however, 4 active range allotments in the Canyon Creek watershed (Sugarloaf, Seneca, Pearson, and Fawn Springs allotments), and the presence of livestock grazing in the watershed can be readily observed in both upland and riparian zones. Although specific data were not available for this watershed analysis, generally livestock grazing is the most widespread land use in the intermountain west. As a disturbance caused by management methods, livestock grazing has been attributed to changes in the structure, composition, and diversity of ecosystems, particularly in riparian zones.

The effects of livestock grazing in riparian zones were recently investigated in floodplain meadows of the Middle Fork, John Day River (Kauffman et al. *submitted*), an area approximately 30 miles away (by air) from the analysis area. The study was a comparison between grazed and ungrazed meadows (exclosures) and determined significant differences in total biomass (i.e., the living plant tissue above and below ground), soil bulk density, and water infiltration rates. Overall, the results demonstrated statistically significant differences between grazed and ungrazed meadows. Biomass in ungrazed meadows was between 61% and 71% higher than grazed meadows, which has direct effects on soil stability and site productivity. Soil compaction was 49% higher in grazed meadows than ungrazed meadows, and water infiltration rates reflected this with ungrazed areas having between 3 and 11 times more water traveling subsurface rather than overland. All of these effects of grazing have long-lasting impacts to the stability of riparian ecosystems in the Blue Mountains, and may be more or less pronounced within the Canyon Creek watershed.

In upland grasslands and shrublands, water and quality forage are generally less available, and in the Canyon Creek watershed, the steep topography of the rangelands likely further encourage livestock to migrate to riparian zones in the valley bottoms. However, evidence of livestock grazing in upland grasslands and shrublands exists in the analysis area, and the secondary effects of grazing in these environments are also visible. Introduction of annual cheatgrass and reductions of biomass and fine fuels are two noticeable effects in the Canyon Creek watershed, although the extent and magnitude of the effects have not yet been quantified.

3.4.2 Mining

According to USFS records, there is one potentially active mining claim in the analysis area. Claim number 0006379 is in Township 14 South, Range 32 East, Section 18. It is referred to as the Iron King Mine or the Billie Girl Mine and it contains chromite. The claim has been current since the 1930s. The owner has been attempting to make the mine operational for the past several years and anticipates operations to commence in 2003. The USFS has completed a mineral examination and determined that the claim is legitimate. In general, mineralization in the region is to the east, northeast, and southwest of the watershed area (Tay, pers. comm. 2003).

The BLM database lists many active mining claims in the analysis area. However, the database does not include information about type of mineral or contamination problems.

3.4.3 Treaty Rights

Two treaties reserve Native American rights in the Canyon Creek watershed: the 1855 treaty with the Walla Walla, Cayuse, and Umatilla Tribes, and the 1855 treaty with the Tribes of Middle Oregon. The Burns Paiute have tribal sovereignty status and resource interest in the watershed. As a result of the 1855 treaties, the Confederated Tribes of Warm Springs and the Confederated Tribes of the Umatilla Indian Reservation have reserved rights to take fish, hunt, gather, and pasture stock in the Canyon Creek watershed. These treaties specifically state that:

> The exclusive right of taking fish in the streams running through and bordering said reservations is hereby secured to said Indians, and all other usual and accustomed stations, in common with citizens of the United States and of erecting suitable buildings for curing the same; also the privilege of hunting, gathering roots and berries, and pasturing their stock on unclaimed lands, in common with citizens, is secured (USFS 1990).

The Confederated Tribes of the Warm Springs Reservation are represented by the 1855 treaty with the Tribes of Middle Oregon (USFS 1997). The entire area of the John Day River Basin is located within the boundaries of the Warm Springs treaty-ceded area (USFS 1997). The Warm Springs Tribes regulate the fishing activities of members on and off reservation lands. Currently, no specific fish harvest management goals or deferments exist between the tribes and the USFS (1997). The Umatilla Tribes adopt and enforce regulations on fishing activity, and are involved in the management of fish resources and implement management practices to protect the resources (USFS 1997).

3.4.4 Recreation

The main types of recreation in the analysis area are hiking, fishing, camping, hunting, horseback riding, and cross-country skiing.

USFS developed sites are listed in Table 3.64 below. Campgrounds are open generally between May 25th and October 31st. None of the campgrounds have trailer or RV hookups. There are five designated horse camps in the analysis area: East Fork Canyon Creek trailhead, Joaquin Miller horse Camp, Parish Cabin Campground, Table Mountain trailhead, and Wickiup campground. The only area plowed open for cross-country skiing within the watershed analysis area is at the Canyon Mountain trailhead.

In the Strawberry Mountain Wilderness, camping and horseback riding are allowed, but no mechanized devices are permitted, including bicycles. Camping is allowed anywhere off the trails in the wilderness. The lakes in the Prairie City Ranger District, east of the analysis area, are stocked with fish. The Wilderness is used most between July and November.

Table 3.64. Developed USFS recreation sites in watershed analysis area.

Name	Facility type	Facilities	Activities/ attractions
Canyon Meadows	campgound	18 tent/trailer campsites, 20 picnic sites, piped water	hiking, hunting, fishing, picnicing, wildlife viewing, wild flower viewing, Wilderness access
East Fork Canyon Creek	trailhead	undeveloped camping, 6-horse tie stall with manger, horse unloading ramp, hitch rail	
Joaquin Miller	horse camp	15 camp sites, 4 corrals, 6 toilets, 2 hitch rails, well with handpump	
Parish Mountain	campground	20 tent/trailer campsites, 1 group camping area, 1 picnic site, 6-horse tie stall, toilets, piped water	stream fishing, hunting, picnicing, wildflower viewing
Starr	campground	8 tent/trailer campsites, 5 picnic sites	snow play area, hunting, snowmobiling, cross-country skiing
Table Mountain	trailhead	undeveloped camping, 6-horse tie stall with manger and hitch rail,	
Wickiup	campground	4 tent sites, 9 tent/trailer sites, corral, 4 picnic sites, 1 group picnic site, toilets, water	stream fishing, hunting, picnicing, historic sites

Source: USFS, 2003

There are several private recreation facilities as well, including J-L Ranch, Ray Cole Camp, Williams Ranch, Yokum Corrals Camp, and Hotel Dekum Camp.

There are three areas within the analysis area that are closed to all motor vehicles except on open roads between December 1st and April 1st, because they are big game winter ranges.

There are approximately 36 miles of mountain bike trails in the analysis area. The trails are on both open and closed roads, which range from paved and graveled to native surface. Most trails are rated in the more difficult and most difficult categories.

There are approximately 36 miles of groomed snow mobile trails in the analysis area. Grooming consists of compacting snow in a 10- to 12-foot-wide trail. Grooming does not disturb soils or impact fish because it is done when the ground is frozen, when the snow is a minimum of one to two feet deep, and it does not remove or side-cast material. At stream crossings, groomers fill streams with snow. The only area plowed open for cross-country skiing within the watershed analysis area is at the Canyon Mountain trailhead.

There are three areas within the analysis area that are closed to all motor vehicles except on open roads between December 1st and April 1st, because they are big game winter ranges. In the Malheur NF, all paved roads (hard surface, single or double lane) and all double lane gravel roads are closed to ATVs (USFS 2003).

The Strawberry Mountain Wilderness with a ROS class of WROS has a pristine and primitive opportunity class. The area within pristine is located around Canyon Mountain in the northwest portion of the wilderness. An extensive unmodified natural environment characterizes the pristine area. Natural processes and conditions have not and will not be measurably affected by the actions of users. Terrain and vegetation allow extensive and challenging cross-country travel. The primitive areas are characterized by essentially unmodified natural environment. Concentration of users is low and evidence of human use is minimal.

In the Wilderness, camping and horseback riding are allowed, but no mechanized devices are permitted, including bicycles. Camping is allowed anywhere off the trails in the wilderness. The lakes in the Prairie City Ranger District, east of the analysis area, are stocked with fish. Under the code-a-site system, 232 dispersed camps have been identified in the Wilderness, although it is unknown how many are within the analysis area. Other than trails, there are no developed facilities in the Wilderness. There are six trailheads in the analysis area with trails that lead into the Wilderness. They are the Road's End, Buckhorn Meadows, Table Mountain, East Fork Canyon Creek, Joaquin Miller, and Canyon Mountain trailheads. There are approximately 42 miles of trails in the Wilderness within the analysis area (Table 3.65, Map 3.18). Most are rated in the more difficult and most difficult categories. Trail facilities found on or adjacent to trails include wooden bridges, wooden footbridges, culverts, and retaining structures. The major maintenance problems for the majority of the trails is due to the large amount of dead and dying trees adjacent to the trail system. General maintenance concerns include drainage structures to protect the trail. There are no current outfitter/guide permits issued for the Strawberry Mountain Wilderness within the planning area. Interest in obtaining a permit is high; until capacity for this wilderness is determined, no permits will be issued.

Table 3.65. Recreational trail networks within watershed boundaries on NFS lands for Canyon Creek watershed.

Trail name	**Length of trail**	**Trail name**	**Length of trail**
Buckhorn Meadows Trail	2.55 miles	Pine Creek Trail	2.99 miles
Canyon Mountain Trail	2.79 miles	Slaughter	0.45 miles
Crazy Creek #17 Bike Loop	6.82 miles	Starr	0.04 miles
Eagle	0.11 miles	Starr Ridge #18 Bike Trail	4.42 miles
East Fork Canyon Creek Trail	9.47 miles	Table Mountain #16 Bike Loop	4.51 miles
Geary Snowmobile Trail	1.28 miles	Table Mountain A Trail	0.86 miles
Indian Creek A Trail	0.001 miles	Table Mountain Trail	6.26 miles
Joaquin Miller Trail	5.56 miles	Tamarack Creek Trail	1.75 miles
Malheur Snowmobile Trail	2.40 miles		

Note some trails cross into neighboring watersheds.

3.4.5 Wilderness

A wilderness area has been historically described as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

The Strawberry Mountain Wilderness is a diverse, high-country rugged wilderness that comprises 44% of the watershed and contains five of the seven major life zones in North America. Glaciations hollowed out beds in U-shaped valleys that today hold seven alpine lakes, rare treasures in Oregon's arid west. Elevation ranges from about 4,000 feet to 9,038 feet atop Strawberry Mountain in the east-central portion.

A ~700-acre Research Natural Area (RNA) was established on August 2, 1960 within the wilderness area of the Canyon Creek watershed (Map 3.18). The RNA varies from 4,700- to 5,900-ft elevation and is situated on a gently south facing enclosed basin that rises from Canyon Creek to moderately steep ridges on the northern and western edges. Slope aspects are east, south, and west. The purpose of the Forest Service RNA designation is to provide areas where certain natural features and ecological processes are maintained in their natural state for educational, ecological and scientific purposes. They are used to provide three main functions: (1) As baseline areas against which effects of human activities can be measured; (2) sites for the study of natural processes in undisturbed ecosystems; and (3) gene pool preserves for all types of organisms, especially rare and endangered types.

The RNA has had a fire history discernible from numerous fire scars, primarily on ponderosa pine. This record shows that low intensity ground fires were quite common at 15- to 20-year return intervals until 1910, when a fire suppression program was initiated. Other disturbances include the presence of sheep grazing until 1946 when the practice was discontinued. Currently there is moderate to high usage of the RNA for grazing by game species, which has resulted in moderate to severe hedging of palatable browse plants.

Currently there are no known ongoing research programs being conducted on the Canyon Creek RNA. A few areas of potential research opportunities have been suggested, including long-term studies of natural forest succession since fire control, the evaluation of seed sources in relation to the distribution of fir reproduction, the effects of various soils and topography on biomass production under a rather homogenous macroclimate, and evaluation of game use on vegetation.